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MILL ORGANIZATION.

GILBERT R. MERRILL

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SOUTHEASTERN MASSACHUSETTS TECHNOLOGICAL INSTITUTE
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1895

MILL ORGANIZATION.

GILBERT R. MERRILL

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Introduction

This set of notes was designed as an outline, around which a course on Mill Organization could be built. Originally published in loose leaf form, this edition has been bound to suit the call for its use outside the class room.

In revising the first edition, considerable material was added all through the text. At the end, text on machinery calculations was added as illustrative of determining the necessary units of different processes to equip a balanced mill. While these calculations illustrate the use of multiple roving operations, they may be readily modified to give the units or machines needed when one long draft roving process is used.

While much of the first edition, with some revisions, was published in The Textile World and Textiles Panamericanos (Spanish Translation), the present form was further revised to include postwar trends in long draft organizations.

The following table of contents is added for the convenience of those not using the material as a course textbook.

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The term organization, as used in this connection, includes the planning of the drafts, doublings, wastes and sizes to use for the production of certain counts of cotton yarns. In addition, it includes the determination of the amount of machinery required to carry out the production of the sizes planned in the proper ratio, so that the product of one operation is sufficient to supply the requirements of the next operation. This involves the selection of the proper speeds, twists and machine details to be consistent with the quality of the yarn to be spun.

At the outset, it must be clear to anyone at all familiar with the cotton industry, that there is no one and only perfect solution for a problem of this type. Starting with the same stock, to make the same yarn, two mills will seldom use exactly the same organization and the yarns that they make may be so nearly alike that there is no choice between them. Yet, after averaging the organizations of a number of mills making comparable yarns, it is surprising how nearly the various organizations approach one another.

So, with this acknowledgement to the differences which some mill men will express, this discussion is offered as filling a gap in the literature of the industry which should not have remained open so long.

In considering this subject, there is a need for a good general, if not even specific, knowledge of common mill conditions. Sometimes a knowledge of mill practice seems to confuse this subject more than to enlighten it, because mills making the same yarns and fabrics will have such different ways of solving their problems. These conditions serve to illustrate that Cotton Manufacturing is still an art and that it has not yet reached the stage of being strictly a science.

Systems Used in Cotton Manufacture.

There are three systems in use for the manufacture of cotton yarns. They may be called by the following names:

1. Regular cotton system.
2. Coiler or double carding waste system.
3. Condenser or woolen principle waste system.

The regular cotton system is that commonly used. It represents the great bulk of cotton manufacture and utilizes the following operations:

Opening, 1 to 5 operations.
Picking, 1, 2, or 3 operations.
Carding.
Combing.
Drawing, 1 or 2 operations.
Roving, 1, 2, 3, or 4 operations.
Spinning.

No further discussion will be used in this connection, as the assumption is that sufficient literature is available for those not already conversant with the system.

The Coiler or Double Carding Waste System.

The coiler or double carding waste system is one used for short staples and wastes. It produces a yarn having the general characteristics of the regular cotton system but lacking in uniformity and strength. In this system the following operations are used:

Opening, 1 to 5 operations.
Picking, 1 or 2 operations.
Breaker Carding.
Doubling.
Finisher Carding.
Roving, 1 or 2 operations.
Spinning.

The conspicuous features of this system are double carding and the omission of drawing. Both cards are of the revolving flat type equipped with fancy rolls to prevent too rapid filling of the cylinders. The breaker card is usually equipped with a side delivery in connection with which a leather apron runs across at the front of the doffer to carry the web.

The doubler, or derby doubler, may be arranged to wind 40, 80 or 96 breaker card slivers into a lap with no draft. The 40 end laps are half the width of the finisher card while the others are the full width of it.

The finisher card is fed one or 2 full width laps or 2 or 4 of the narrow laps. This means, 80, 96, 160 or 192 breaker card slivers are fed the finisher card. The doffer web is separated into 2, 4, 6 or 8 sections. Each is run through a trumpet and to a separate coiler and can.

The finisher card slivers are fed to the slubber, and for the coarser yarns, the slubber roving goes directly to the spinning frame. The finer yarns are made from roving which is made on an intermediate frame.

The Condenser or Woolen Principle Waste System.

The condenser or woolen principle waste system is so called because it is very similar to the regular woolen yarn system, producing a yarn in which there is no regular fiber arrangement and from which the fibers project in every imaginable direction. This type of yarn is particularly suited to fabrics requiring napping. The operations involved in this system are as follows:

Opening, 1 to 5 operations.
Picking, 1 or 2 operations.
Double carding in tandem, (Roller cards)
Spinning.

Where colored work is run on this system, which is quite often, the stock is opened, dyed, dried and baled. After this it is put through the operations listed above.

In this system, the carding is done on the roller and clearer type of cards, the first of which delivers its end as a single sliver, which is automatically carried to the feed apron of the second or finisher card. The latter has an automatic feed arrangement to lay the breaker sliver diagonally across its feed apron. The finisher card web is split up into a series of very narrow ribbon which are passed between two rub aprons, whi roll the ribbons into several rovings which are rolled up on double headed rolls, called jack spools. These spools are placed in the creel of a special type of ring spinning fra The spools rest on and are turned by a drum, which causes them to deliver the required ya age. In many of these frames, the ends mere pass between two rolls and down to the trave er and bobbin. This is really no more than twister. In some cases, a strand of fine cc ton yarn is run along with this yarn to give the final strand a better strength. This is called a "core yarn".

Another type of spinning frame for this system has two pairs of rolls about 15 inche apart. These rolls can be arranged to give draft up to 2 from which the end is twisted in the first type of frame.

Regular Cotton System.

Drafts and Sizes.

There are a series of items that should be taken into consideration before starting out on a discussion of a regular cotton syst mill organization. These include the detail regarding common practice in the various ope ations. The table on the following page giv a summary which can be used as a general bac ground for this work.

Roving Operations.

Another feature that needs some conside ation is the number of roving operations com monly used for various counts of yarn. Thes will vary depending upon the quality of the yarn being made. Likely conditions are shov in the following paragraphs, which include some of the more common uses for the yarns mentioned. This data is based on the older style organization where no long draft was

Range of Drafts and Sizes.

Operation	Drafts		Sizes	
	Range	Common	Range	Common
Breaker Picker	1.5-2.5	2	14 - 18	16
Finisher Picker	3 - 5	4	12 - 16	13
Single Process Picker				
Card	80 -120	100	40 - 80	55
Sliver Lapper	1.5-2.5	2	400-800	500
Ribbon Lapper	4 - 6	4	400-800	500
Comb	40 - 80	60	50 - 65	60
Drawing, 4 Roll	5 - 7	6	40 - 70	55
5 Roll	16 - 18	16	40 - 70	55
Slubber, Regular	3 - 5	4	.40-.70	.50
Long Draft	6 - 10	7	1.00-1.50	1.10
Intermediate, Regular	4 - 6	5	1.00-2.00	1.30
Long Draft	12 - 40	24	up to 6.00	4.00
Fine, Regular	5 - 7	6	2.50-6.50	4.00
Jack, Regular	6 - 9	7	8.00-15.00	10.00
Spinning, Regular, Single Rov.	7 - 9	8		
Double Rov.	9 - 12	10	10.00-120	20.00
Long Draft	14 - 20	16		

used.

Using one operation of roving permits making yarns up to 10s for filling of napped goods, candle and lamp wicking, coarse denims and in plies for such materials as ducks- wide, narrow, belting and hose.

Using two operations of roving permits making yarns up to 20s for ducks- canvas, drills, baggings and coarse sheetings.

Using three operations of roving permits making yarns from 15s to 40s for weaving, suitable for medium sheetings, print cloths, cheese cloths, drills and twills. For the better grades of work, the range may be from 15s to 30s. This is especially true for yarns for the knitting trade, suited to hosiery, and underwear fabrics.

Using four operations of roving permits making yarns from 40s to 150s for voiles, lawns, organdies, piques, shirtings, fine sateens, velveteens and airplane and balloon cloth. The lower end of the range may drop as low as 30s for some high grade work, especially knitting yarns.

Using five operations of roving permits spinning the finest of yarns. This arrangement is rarely used and then it is for yarns from 150s and up.

In the use of long draft on roving frames, there are two general classes of frames. The long draft sulbbers are, commonly, three roll slubbers with some features to help in drafting. Such frames ordinarily have drafts ranging from 6 to 10 and produce hanks from 1.00 to 1.50. This permits spinning yarns up to 16s, easily, and, in extreme cases, yarns up to 22's.

The Interdraft roving, using two stages of two roll drafting, uses drafts ranging from 10 to 16 making possible rovings from 1.50 to 2.50 hank, which may be suited for yarns from 10's to 24's.

The more common long draft frames of the various makes are suited for drafts from 16 to 40, producing hanks from 2.50 to 6.00. Such rovings may be spun to counts from 20's to 50's. Thus, one operation of roving may produce up to 6.00 hank, with 4.00 hank as a very common size. Notice that this means that one operation produces a fine roving size. However, this does not require as long a draft as might be first thought because there is no doubling. Thus, when standard three process rovings would use a total draft of 120, a long draft frame needs only a draft of 30.

Use of Combing.

Yarns finer than 40s are usually of combed cotton, which means that sliver lappers, ribbon lappers and combs follow the carding. It will be understood that special yarns are often made where combing is used for very coarse numbers, so that this item is not entirely dependent on the count being spun.

Cotton Staple Used.

Another factor of importance, having a connection with the counts spun, is the staple of the cotton necessary to produce a commercially satisfactory yarn. Again, there is a chance to vary some but the table below represents practice within the usual commercial limits.

In establishing the "base grade" yarn for O. P. A. pricing during the war. Base grade was of staple which did not exceed the staples listed below.

Carded Yarns.

Staple	Counts
15/16	6 to 16
1	17 to 24
1 1/16	25 to 34
1 3/32	35 to 40
1 1/8	41 to 50

Combed Yarn.

1 1/16	8 to 24
1 3/32	25 to 30
1 1/8	31 to 44
1 5/32	45 to 54
1 3/16	55 to 70
1 7/32	71 to 80
1 1/4	81 to 90
1 5/16	91 to 100
1 3/8	101 to 120
1 7/16	121 and up

Counts Spun from Various Staples of Cotton.

Staple	Carded		Combed	
	Warp	Filling	Warp	Filling
Up to 1"	Up to 28	Up to 36	--	--
Up to 1 1/8	--	--	Up to 30	Up to 40
1 1/8 to 1/4	30 - 50	40 - 60	30 - 60	40 - 70
1 1/4 - 3/8	50 - 75	60 - 80	60 - 70	70 - 100
1 3/8 - 1/2			70 - 80	100 - 120
1 1/2 - 5/8	75 - 100	80 - 120	80 - 100	120 - 150
1 5/8 to 3/4			100 - 180	150 - 180
1 3/4 - up			150 - 300	150 - 300

The Effect of Twist Contraction in Organization.

The shortening of a strand due to twisting causes it to increase in weight and so the number of the yarn is lower. The low twist used in roving may cause some slight contraction but it would be very difficult to measure it and it is generally neglected.

Contraction in spinning, where there is considerable twist, is sufficient to cause appreciable error if neglected. The best way to measure spinning twist contraction is by means of a 2-ply measuring yarn run under one boss of the top roll spinning the yarn. It is generally considered necessary to have the ply measuring yarn as fine or finer than the yarn being spun. The measuring yarn may be run onto a reel but usually several ends are run at once and are wound on the scavenger rolls.

Twist contraction in single yarn frequently runs higher than is commonly expected. Chart 1 shows a plot of figures for twist contraction between the twist multipliers of 3 and 8.

The percent contraction is calculated from the basis of the untwisted length at the front roll, which is the length obtained by use of the ply measuring yarns.

$$\text{Percent Contraction} = \frac{\text{Length at Front Roll - Length of Yarn Spun}}{\text{Length at Front Roll}}$$

Example 1. What is the percent contraction when the average length of the measuring yarns is 872 yards and the average length of the yarns spun is 821?

$$\text{Percent Contraction} = \frac{872-821}{872} = \frac{51}{872} = 5.85\%$$

In using the percent contraction when dealing with counts, the expression must be different. A shorter length, containing the same quantity of cotton, must be a coarser count, which means a lower number. This means that the count at the front roll is higher than at the bobbin. As it is customary to find the count of the yarn on the bobbin (after contracting), it is desirable to have some simple method of calculating what the counts at the front roll (before contracting) must be to give the counts needed on the bobbin.

If Yf is yardage at the front roll,
Yb is yardage at the bobbin,
Cf is counts at the front roll,
Cb is counts at the bobbin,
W is weight in pounds of the material, both before and after contracting,
K is 1.00 less contraction expressed as a decimal.

The following will show that:

$$\text{Counts at the Front Roll (Cf)} = \frac{\text{Counts on the Bobbin (Cb)}}{\text{1.00 - percent Contraction (K)}}$$

1) $Yb = Yf \times K$

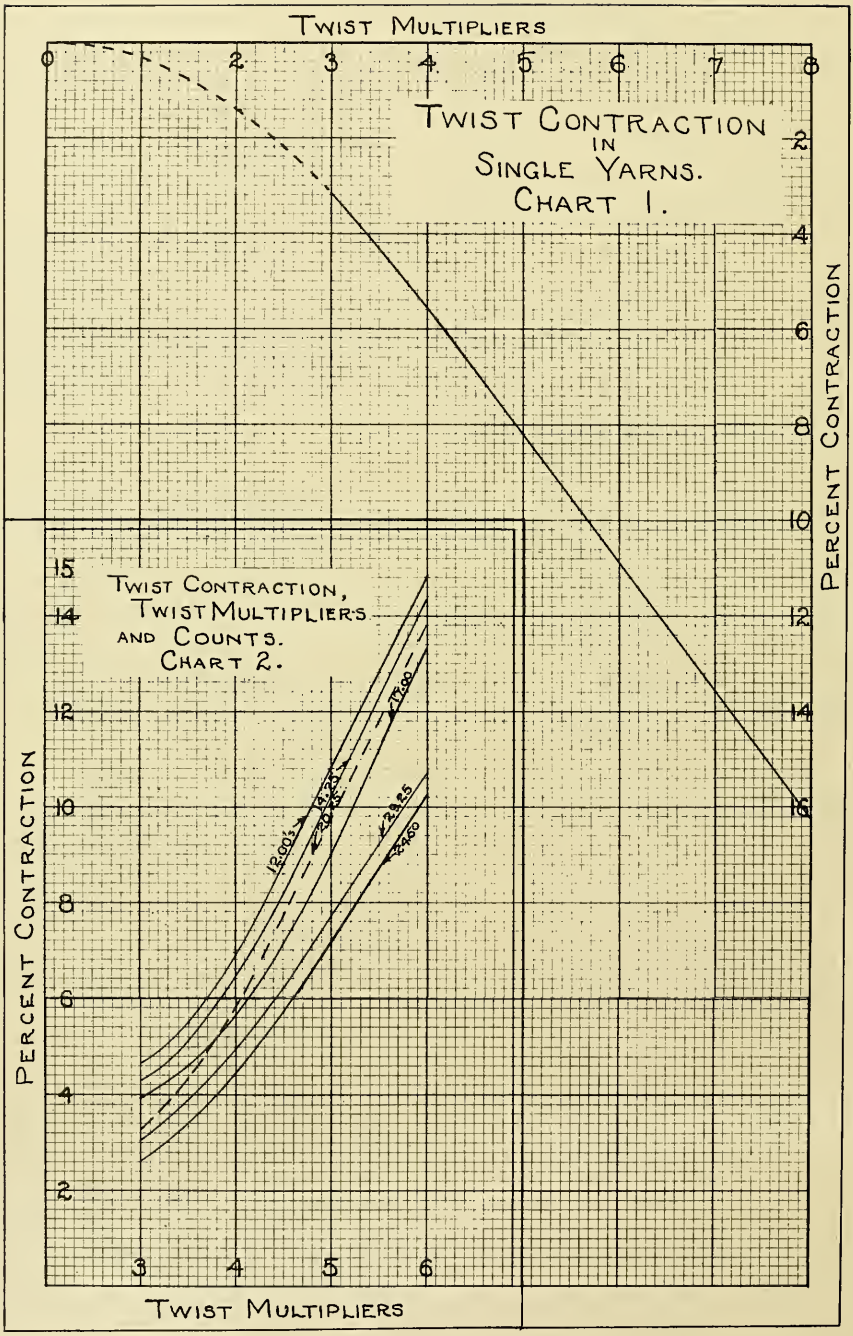
2) $Yf = \frac{Yb}{K}$

3) $Cf = \frac{Yf}{W \times 840}$

4) $Cf = \frac{Yb}{K \times W \times 840}$

5) $Cf = \frac{Cb \times W \times 840}{K \times W \times 840} = \frac{Cb}{K}$

Frequently there is the question, "May we not multiply the counts on the bobbin by 1.00 plus the percent contraction?" While the numerical value is practically equal to the correct method for the more common cases, there is considerable error in the cases with high percentages of contraction.


Twist Multipliers
Twist Contraction in Single Yarns. Chart 1.
Percent Contraction
Twist Contraction, Twist Multipliers and Counts. Chart 2.
Percent Contraction
Twist Multipliers
12.00
17.00
20.00
23.25
24.50

Example 2. If a 20s yarn is on the bobbin and the contraction is 10%, what is the count at the front rolls?

$\frac{20}{1.00 - .10} = \frac{20}{.90} = 22.22$s at the front rolls.

When 20s is multiplied by 1.10 the result is 22.00s at the front rolls, showing an error of about 1%.

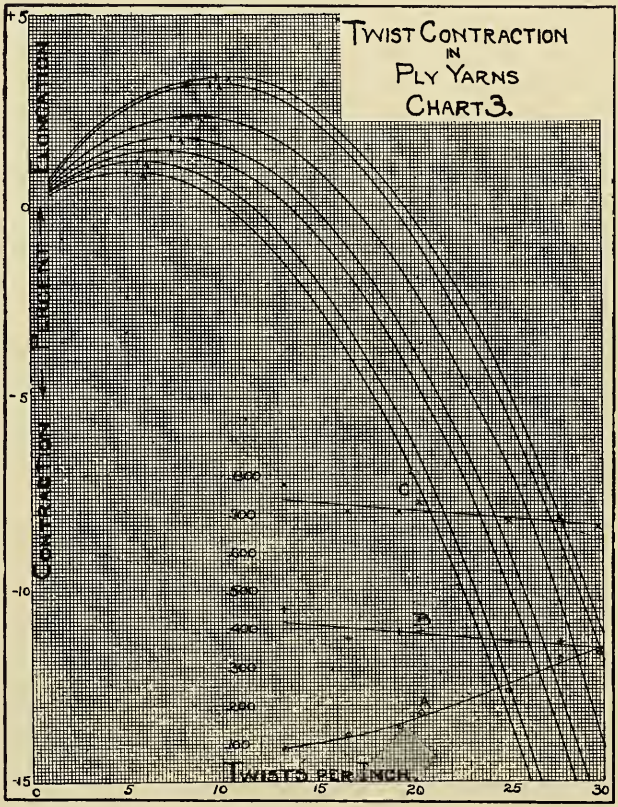
Consequently, from the theoretical standpoint the second method is wrong.

While the contraction plot shown in chart I is the most commonly accepted relationship between contraction and twist, some experienced spinners feel that the contraction is not the same for all counts. A study[1] conducted along this line gave the series of curves shown in chart 2. The yarns studied were single carded counts from 13's to 30's. The conclusions based on this study were that all counts have the same general curve representing contraction but that the amount of contraction was high in coarse counts and gradually decreased as the counts were finer. It has been proposed that the equation representing contraction may be something like the following:-

[1] A. J. Woodbury and R. P. Webb Thesis, Lowell Textile Intute, 1942.

M = twist multiplier
K = constant = .967 for single carded yarns.
A = number of increments (.5 each) of twist multiplier above or below 5.00 (+ if above, - if below). Omit this factor for counts between 20's and 30's

$$\text{Percent Contraction} = \frac{M\left[K + (A)\ (0.015)\right]}{\sqrt[3]{\text{counts}}}$$



Ply Contraction.

The effect of ply twist on the resulting counts is an involved relation on which too little work has been done to draw many conclusions. However, for any ordinary 2 ply yarn with reverse twist, it can be found that as the ply twist is being inserted the yarn elongates for the first few turns and then it contracts. The amount of elongation depends upon the twist in the single yarns. Once the contraction starts, the curve representing it seems to be similar for all single twist conditions.

Chart 3 shows the elongation and contraction when twisting 13s two ply. Seven lots of singles, ranging in twist from 13.3 to 29.8 turns per inch are shown. Elongation is represented above the zero line and contraction below it. The short vertical line at the peak of each curve indicates half the distance between the starting point and where the contraction exactly equals the elongation. The arrow heads indicate points beyond which each curve is like the others. This seems to indicate that once the elongation is completed, contraction is much the same for each of the single twists.

The Effect of Waste Removal in Organization.

The losses due to the removal of tare and wastes are very important factors in the cotton manufacturing program. First, the actual loss of materials, which reduces the final quantity of cotton available for yarns or fabrics, increases the cost of the material remaining and so is important. Second, due to the reduction of quantity at different operations, fewer machines are required than would at first be expected. Third, operations having a high percentage of waste require less mechanical draft because of the reduction due to waste removal.

In connection with cost and production, it is customary to consider the waste in each operation. However, it must be remembered that in most mills good lap ends, sliver waste and roving, which have been opened, are all taken back to the opening or picker room, where they are put in with the raw stock.

In connection with mechanical draft, it is customary to neglect the losses at the drawing rolls and to treat drawing, roving and spinning as though no losses occurred. The losses in opening are not considered in connection with draft because there is no size of product being delivered. The operations of picking, carding and combing are those where the wastes must be considered in connection with the mechanical drafts used.

For opening and picking, the common practice is to base all waste percentages on the original weight in the bales. This is because there is no place to weigh the stock from the time it is in the bales until it gets into lap form. For carding and beyond, the percentage of waste given is based on the weight fed the particular operation.

The Waste Factor.

A waste factor is a number which may be used to show the relation between the value of raw cotton and the same cotton in the yarn or fabric. The factor depends upon the following items:- first, the quantity of wastes removed in processing, second, the amount of waste returned to the same product, and third, the value of the wastes sold.

There are several uses which may be made of data developed in calculating the waste factor. From some of the intermediate data, it is possible to estimate the amount of raw stock necessary to produce a given quantity of yarn.

From the completed calculation, it is possible to ascertain the cost of the cotton present in the yarn. This im important in estimating the cost of producing a given yarn. As the fluctuations in the price of raw cotton are often quite frequent and sometimes quite considerable and, as the raw material may constitute up to one half the cost of the yarn, a quick method for estimating the value of the cotton in the yarn is quite necessary. Generally speaking, other items which enter the cost of yarn do not vary as frequently nor as much as raw cotton.

A third place where the waste factor may be of help is in segregating cotton cost from other items. As the economist rates the service of an industry by the "value added in manufacture", it may help to use the waste factor in determining what the "value added" is.

The simplest method of determing a waste factor is to assume a given weight of raw stock in the bale, say 100 lbs., and determine the factor from that quantity of cotton. It must be kept in mind that, beyond picking, the percent of waste for each operation is based on the weight fed that operation which means it is based on the weight delivered by the preceding operation. It is possible to add all the losses through picking, when they are all based on the gross weight of the raw stock in the bale. If these percentages are determined otherwise, it will be necessary to treat them accordingly.

Example 3. What is the waste factor when the following losses prevail?

Tare 5%, Opening 4%, Picking 1%, Carding 7%, Drawing 1%, Roving 2%, and Spinning 3%.

Tare, opening and picking, total 10%.

100 x .90 x .93 x .99 x .98 x .97 = 78.77 lbs. of cotton in the yarn made from the original 100 lbs.

However, wastes from drawing and roving and parts of the waste from carding and spinning are returned to the original stock.

In the table on next page, the columns are arranged to show the calculations used for this illustration. The first column shows the processes in proper sequence. Column two shows the weight of stock fed to each process. Column three shows the percent of loss in each operation. This figure includes the wastes removed by each machine and an allowance for stock not delivered in usable form, such as lap ends, broken slivers and the short lengths of roving remaining on bobbins when taken from the creel. (The losses through picking are all based on the original weight of cotton in the bale while all others are based on the weight fed to that particular operation.)

The weight fed the operation is multiplied by 1.00 minus its percent of waste to determine the weight delivered which is shown in column four. The differences between the figures in column two and column four show the loss of stock in the process. These losses are tabulated in column five.

Lap ends, broken sliver and roving, which may be opened and returned to the same mix, represent the portion of loss which is returned and is tabulated in column six. Column seven gives the portion of the loss which is sold as waste. Column eight gives the price per pound received for each type of waste and column nine shows the total cents received from the sale of each waste.

The final figure in column four shows 78.77 pounds of yarn spun from each original 100 pounds of baled raw cotton. The total of the items in column six shows the total pounds of material lost in processing, which is returned. In this case, it is 5.91 pounds. On the assumption that this material is very largely good clean cotton, it is considered that there is a negligible loss from this stock as it is reprocessed with new cotton. Consequently, the total amount of 5.91 pounds is added to the 78.77 pounds giving a final, corrected figure of 84.68 pounds of yarn from each 100 pounds of raw cotton and the stock reprocessed with it.

The total of column nine shows 76.20 cen received from the sale of wastes from each 10 pounds of bales raw cotton. This amount of m should be deducted from the cost of the 100 pounds of cotton to determine the net cost of raw cotton. The price of the cotton used for this illustration was 12.40 cents per pound. At this price, 100 pounds cost 1240 cents, fr which should be deducted 76.20 cents, giving net cost of 1163.80 cents for the cotton in t 84.68 pounds of yarn. This makes the value o the cotton in each pound of yarn 13.74 cents. The ratio between 13.74 cents and 12.40 cents is 1.109 and this is called the "waste factor".

Waste Factor.

Operation	Weight Fed	Waste %	Weight Del.	Weight Lost	Weight Returned	Weight Sold	Price Per Lb.	Valu
						3.50	1.0	3.5
Tare	100.00	5	95.00	5.00		1.50	.5	.7
Opening	95.00	4	91.00	4.00		4.00	3.0	12.0
Picking	91.00	1	90.00	1.00		1.00	3.0	3.0
Carding	90.00	7	83.70	6.30	1.80	4.50	11.47	51.6
Drawing	83.70	1	82.86	.84	.84	----	-----	----
Roving	82.86	2	81.21	1.65	1.65	----	-----	----
Spinning	81.21	3	78.77	2.44	1.62	.82	6.50	5.3
Wastes returned and sold					5.91 lbs.			76.2

100 x 12.40 = 1240 ¢ for raw stock.
1240 - 76.20 = 1163.80 ¢ net cost of stock in the yarn.
78.77 + 5.91 (wastes returned) = 84.68 lbs. yarn from 100 lbs.
1163.80 ÷ 84.68 = 13.74 ¢ per lb. of stock in the yarn.
13.74 ÷ 12.40 = 1.109 waste factor.

To give some idea of common commercial waste factors, the following table is taken from figures established by O. P. A. during World War II (1944) in connection with establishing price ceilings for combed yarns.

Table of Net Waste Factors

American Peeler		Long Staple	
Staple	Factor	Staple	Factor
1 1/32	1.26	Pima	1.35
1 1/16	1.28	SxP	1.35
1 3/32		Egyptian	1.43
1 1/8	1.31	Sea Island	1.43
1 5/32			
1 3/16	1.33		
1 7/32			
1 1/4	1.36		
1 11/32			
1 3/8 & over	1.38		

Cotton Yarn Strength Standards.

A number of standards have been developed to show how strong ordinary cotton yarns should be. The best known of these are the "Breaking Weights of American Yarns Spun from American Cotton". There are two parts to the table, commonly called respectively, the "Old Draper Standard" and the "New Draper Standard". The New Draper Standard includes three columns giving figures for Carded Warp, Combed Warp and Soft Twist yarns.

As explained in Textile Texts the old standard was developed about 1886 and represented average conditions of that day. The new standards were developed about 1917 and are based on the following equations for 120 yard skein breaks.

$$\text{Carded Warp} = \frac{1900 + \text{counts}}{\text{counts}} = \text{lbs.}$$

$$\text{Combed Warp} = \frac{2600 - (4 \times \text{counts})}{\text{counts}} = \text{lbs.}$$

$$\text{Soft Twist} = \frac{1900 - (13 \times \text{counts})}{\text{counts}} = \text{lbs.}$$

Another set of standards for yarn strength, developed by F. P. Sheldon and Sons of Providence, Rhode Island and published in their "Miscellaneous Scientific Papers, 1926" (L.T.I. 677.1-68) takes into account the staple of the cotton used for the yarns. These charts are based on the formulae which are stated on the following pages. Each chart includes a plot of the Draper standard for comparison.

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Breaking Strength of Cotton Warp Yarn

(Charts Made by F. P. Sheldon & Son, Engineers and Architects, Providence, R. I.)

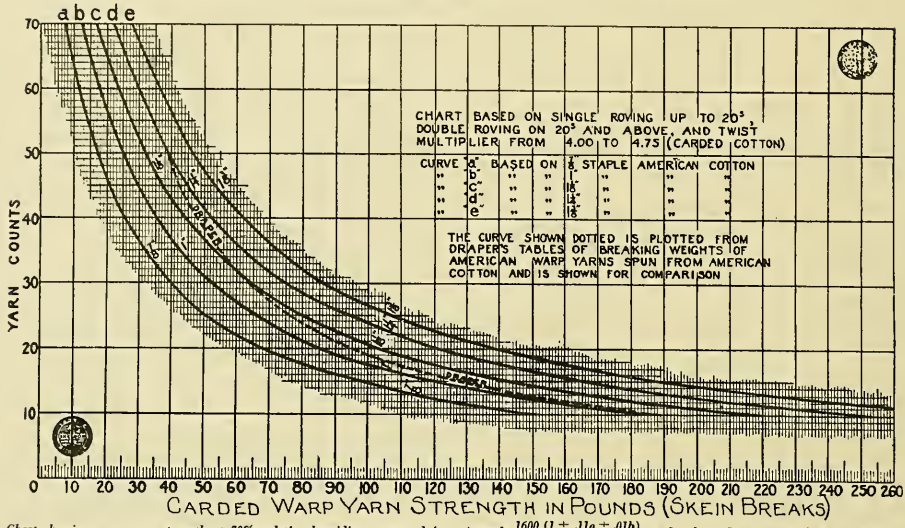

a b c d e
CHART BASED ON SINGLE ROVING UP TO 20s, DOUBLE ROVING ON 20s AND ABOVE, AND TWIST MULTIPLIER FROM 4.00 TO 4.75 (CARDED COTTON)
CURVE a BASED ON 8 STAPLE AMERICAN COTTON
" b " " " 12 " " " "
" c " " " 14 " " " "
" d " " " 16 " " " "
" e " " " 18 " " " "
THE CURVE SHOWN DOTTED IS PLOTTED FROM DRAPER'S TABLES OF BREAKING WEIGHTS OF AMERICAN WARP YARNS SPUN FROM AMERICAN COTTON AND IS SHOWN FOR COMPARISON
YARN COUNTS
DRAPER
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260
CARDED WARP YARN STRENGTH IN POUNDS (SKEIN BREAKS)

Chart showing warp yarn strength at 70% relative humidity, computed from formula $\frac{1600\ (1 \pm .11a \pm .01b)}{C} = S$, *where* C = *counts,* S = *strength in pounds,* a = *difference in sixteenths of staple over or under one inch; use* + *sign when over,* − *sign when under.* b = *difference in number of yarn above or below 28s; use* − *sign when over 28s and* + *sign when below.*

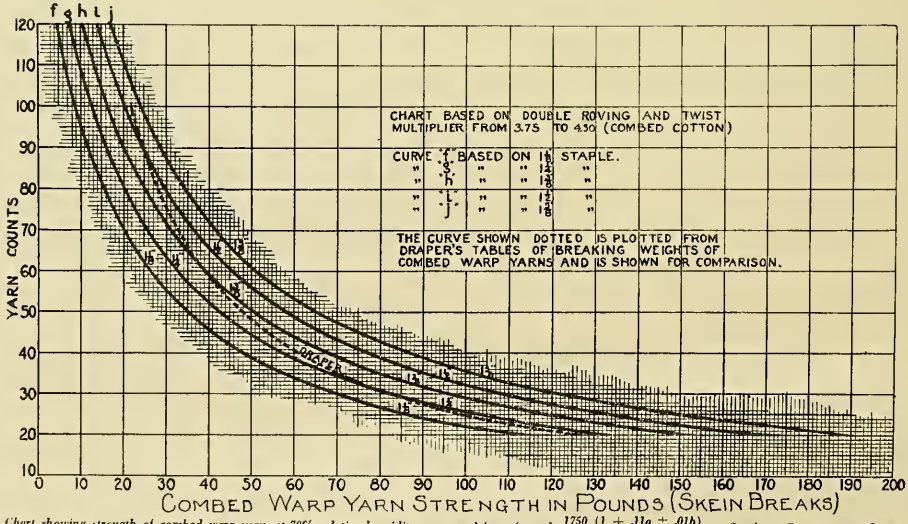

f g h i j
CHART BASED ON DOUBLE ROVING AND TWIST MULTIPLIER FROM 3.75 TO 4.50 (COMBED COTTON)
CURVE f BASED ON 12 STAPLE.
" g " " " 14 " "
" h " " " 16 " "
" i " " " 18 " "
" j " " " 20 " "
THE CURVE SHOWN DOTTED IS PLOTTED FROM DRAPER'S TABLES OF BREAKING WEIGHTS OF COMBED WARP YARNS AND IS SHOWN FOR COMPARISON.
YARN COUNTS
DRAPER
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
COMBED WARP YARN STRENGTH IN POUNDS (SKEIN BREAKS)

Chart showing strength of combed warp yarn, at 70% relative humidity, computed from formula $\frac{1750\ (1 + .11a \pm .01b)}{C} = S$ *where* C = *counts,* S = *strength in pounds,* a = *difference in sixteenths of staple over one inch.* b = *difference in number of yarn above or below 28s; use* − *sign when over and* + *sign when under 28s.*

Planning Organizations.

The cotton yarn organizations used as the following illustrations are taken from mills with long established experienced in producing such yarns. In some cases, an organization has been modified slightly to avoid having it too obvious from which mill the illustration was taken. Organizations for 6's, 13's, 22's, 50's and 80's have been selected as representative for counts from 1, 2, 3 and 4 roving operations. It should be understood that, by slight modifications of the drafts and sizes, it is possible to adapt each of these organizations to counts somewhat coarser or finer. The organization for 30's and 36's printcloth yarns is used to illustrate producing two counts carried along together as far as possible. This illustration represents a great volume of yarns (for print cloth yarn fabrics) not very much above the average count for the United States. This organization is used later for calculating machinery for an entire gray print cloth mill.

Finally, the coarse sheeting organization is used to illustrate what may be done in a mill producing many counts but of the same general quality. This serves as the background for a problem on the division of spindles to meet specified requirements.

By studying the organizations of several different mills for different counts, it is possible to establish a background of approach so that a student may build his own organization from the fundamental data covered in the preceding pages. This procedure is described at the close of the organization for 22's sheeting yarns and may be used in a modified form for any problem in organization.

The introduction of long draft for spinning and roving has made a great change in the problem of organization. Long draft equipment has made it quite practical to produce any count up to 40's with but one roving operation. This eliminates the need to establish several roving drafts, in some definite proportion, to distribute the reduction over several operations. Modifications to illustrate the changes when using long draft, follow each standard draft organization.

Organization for 6's Yarn.

The yarns considered in this organization are suitable for towel filling, bedspread filling, soft duck, denims on similar products. But one roving was necessary and single roving was used for spinning. While one or two drawing operations may be used, this mill used two operations.

Cotton for this yarn may range from ¾ to 15/16 inches in staple. This means th the roll drafts should not run too high. twist should be a little above the standa for one inch cotton, so a spinning multip of 3.75 is used and gives about five per spinning contraction.

One Roving Operation..
Two Drawing Operations.

Single Roving in Spin
5% Spinning Contracti

Contraction 5% .95) 6.00
Spinning draft 10.5) 6.32 at front roll.
Slubber draft 4.32) .60 hk. Slubber.
* .139 hk. or
60 gr. Drawing sliver.
Drawing draft 6
Ends up. 6)360
60 gr. First drawing sliver.
Drawing draft 6
Ends up. 6)360
60 gr. Card sliver.
Card draft 103
Card waste 7%-.93)6180
437.5)6645 gr.
15.19 oz. lap called 15.25.
Horizontal Opener
Vertical Opener
Buckley Opener
Bale Breaker or Bale Breaking Feeders

*To change from hank sliver to grain sliver divide 8.33 by the hank to get the grains per yard or divide 8.33 by the grain sliver to get the hank, e.g. 8.33 ÷ .139 = 60 grain sliver.

Long Draft for 6's.

The advantages in using long draft for such coarse counts as 6's are not as great as for finer counts but the following modification of the above organization shows what may be done

It is assumed that long draft will be used only in spinning and that the standard organization will be followed as far as possible.

One Roving Operation.
Two Drawing Operations.

Single Roving in Spinning.
5% Spinning Contraction.

Contraction 5% .95)6.00
Spinning Draft 12.64)6.32
Roving Draft 3.60) .50
.139 hk.

From this point back, follow the preceding organization. The advantages of this change are: first, that .50 hank is produced at a higher rate than .60 hank and, second, that the better control by the long draft spinning equipment may give a better quality of yarn than that produced with the standard draft equipment.

Using long draft at the spinning frames may reduce the number of slubber spindles necessary by about 20%, as is shown in the following table.

System	Hank	Lbs. 10 Hrs.	Spindles per 5000 Lbs.	Reduction.
Standard	.60	19.25	260	---
Long Draft	.50	24.00	208	52 Sp.

Organization for 13's Sheeting Yarns.

In the earliest days of the American cotton industry a common fabric had 14's warp and filling yarns with 48 ends and picks per inch. This construction has continued to be a volume product for more than 100 years. There are many mills which make a 40 inch-48 x 48 - 2.85 yard sheeting today. This construction requires about 13's warp and 13's filling. The organization given here may be modified to spin yarns from 11's to 15's.

The more common uses for this coarse sheeting are children's clothes, aprons, house dresses, work clothes, roller shades, rubber shoe tops and linings, bags, strainers, hose, belts, oil cloth, auto tires and artificial leather for book b ing, auto tops and upholstery.

Cotton for these yarns varies from 7/8 inch in staple and from Low Middling to Midd in grade.

Two processes of roving are commonly us with single roving in spinning. One or two esses of drawing are used depending upon loc conditions. One process will be used in thi lustration.

Considering this organization as suited both warp and filling and using multipliers about 4.75 and 3.50, respectively, the contr tions would be about 7-1/2% and 4-1/2%. Tak an average for these two gives about 6% cont tion which is used for this example.

Two Roving Operations.
One Drawing Operation.

Single Roving in Spinning
6% Spinning Contraction.

Contraction 6%	.94)	13.00
Spinning draft	7.47)	13.83 at front roll.
Intermediate draft	6.72)	1.85 hk. Intermediate roving.
		.275
Intermediate doublings		x 2
Slubber draft	3.63)	.55 hk. Slubber roving.
		.1515 hk. or
		55 grain Drawing sliver.
Drawing draft		6
Drawing doublings	6)	330
		55 grain Card sliver.
Card draft		111
Card waste 7%	.93)	6105
	437.5)	6560 grains or
		15 oz. Picker lap.

Horizontal Opener
Vertical Opener
Vertical Opener
Bale Breaker or Bale Breaking Feeders.

Long Draft for 13's.

A mill manufacturing this class of yarns was modernized by the introduction of long draft on the intermediates and spinning. The original organization spun 13's from 1.90 hank intermediate roving made from .67 hank slubber roving. The drawing was fed eight slivers instead of six. While this mill was far removed from the example given on the preceding page, note the similarity of the organizations. In remodelling, the intermediates were "changed over" to long draft.

Note that the "change over" does not change the count spun but does change the hank roving for spinning. The roving draft is relatively high but is well within the range recommended for long draft slubbers.

The modernization made possible the use of .90 hank roving, made in one operation from drawn sliver. This eliminated the use of the original slubbers and, because of the high production of .90 hank on the intermediates, only about 40 percent of these needed to be remodelled to produce the necessary poundage. This reduced the number of operatives necessary to run the frames and handle the roving and reduced the amount of power for operation. There is but very little saving in floor space because the converted intermediates had to be rearranged to allow a large space behind each for the cans of drawn sliver.

Note that long draft in spinning did not reduce the number of spinning spindles required and that savings resulting from its use were made in the card room at the roving frames.

One Roving Operation.
One Drawing Operation.

Single Roving in Spinning.
6% Spinning Contraction.

Contraction 6%	.94	) 13.00	
Spinning draft	15.37	) 13.83	at front roll.
Roving draft	7.03	) .90	hk. roving.
		.128	hk.
		65	grain Drawn sliver.
Drawing draft		6.16	
Drawing doublings	8	)400	
		50	grain Card sliver
Card draft		108.5	
Card waste 7%	.93	)5425	
	437.5	)5833	
		13.33	oz. Picker lap.

Horizontal Opener
Buckley Opener
Buckley Opener
Blending Feeders

Organization for 22s Sheeting Yarn.

Sheetings of the weights called medium and fine represent the large volume of the home sheeting consumption, are woven from yarns ranging from 20s to 26s warp and filling. These are sold "brown" (unbleached) or bleached, as yard goods or made up into sheets. The widths vary from 36 to 108 inches, with a decided tendency to the wider widths in preference to two narrow strips sewed together. These sheetings are also used for bags, work clothes, foundations for imitation leather, in rubber goods, bookbindings and window shades.

The cottons used range from 1 inch to 1-1/16 inches about Middling grade. Some mills mix up to 1 bale of spotted cotton with 7 bales of white cotton, finding that the color is sufficiently mixed to give a uniform color effect in the fabric.

Three processes of roving (regular draft are used and generally two processes of drawing.

The yarn used for this illustration was 22's filling with a twist multiplier of about 3.75 which gave a contraction of about 5%. When using standard draft in roving and spinning, the common practice was to use double roving in spinning which required three processes of roving. Two processes of drawings were commonly used for this work.

Three Roving Operations.
Two Drawing Processes.

Double Roving in Spinning
5% Spinning Contraction.

Spinning contraction 5% .95) 22.00
Spinning draft 10.29) 23.16 at front roll.
2.25
Spinning doublings x 2
Fine draft 6.43) 4.50 hk. Fine roving.
.70
Fine doublings x 2
Intermediate draft 5.60) 1.40 hk. Intermediate roving.
.25
Intermediate doublings x 2
Slubber draft 3.59) .50 hk. Slubber roving.
.139 hk. or
60 grain Second drawing sliver.
Second drawing draft x 6
Second drawing doublings 6) 360
60 grain First drawing sliver.
First drawing draft x 6
First drawing doublings 6) 360
60 grain Card sliver.
Card draft x 101
Card waste 7% .93) 6060
437.5) 6517
14.9 oz. or 15 oz. Picker lap.
Buckley Opener
Buckley Opener
Vertical Opener
Bale Breaker or Blending Feeders

Long Draft Modification.

The following organization was used by a mill after one of the early installations of long draft equipment on the spinning frames. The mill continued to use three processes of roving, two of drawing and double roving in spinning.

Spinning contraction 5% .95)22.00
Spinning draft 13.23)23.16 at front roll.
1.75
Spinning doublings x 2
Fine draft 5.83) 3.50 hk. Fine roving.
.60
Fine doublings x 2
Intermediate draft 4.80) 1.20 hk. Intermediate roving.
.25
Intermediate doublings x 2
Slubber draft 3.59) .50 hk. Slubber roving.
etc.

From this point back, the organization was the same as for the regular layout. The accompanying table shows how fewer roving spindles were necessary to supply the needs of 10,000 spindles. While no process has been omitted, nearly one third of the fine spindles and nearly one fifth of the intermediate spindles may be eliminated.

Comparative Table.

	Standard Organization.			Long Draft Organization.		
	Size.	Pounds 10 Hours.	Spindles.	Size.	Pounds 10 Hours.	Spindles.
Spinning	22.00	.38	10,000	22.00	.38	10,000
Fine	4.50	1.85	2,097	3.50	2.61	1,486
Intermediate	1.40	7.82	501	1.20	9.47	414
Slubber	.50	24.00	165	.50	24.00	165

In more recent use, when changing to long draft in both spinning and roving, it is most likely that the spinning draft would be increased to nearer sixteen. When used as shown below, it requires 3.00 hank roving, which can very readily be made on one process of long draft roving, as shown in the following tabulation.

Spinning contraction 5% .95)22.00
Spinning draft 15.44)23.16 at front roll.
1.50
Spinning doublings 2
Roving draft 21.57) 3.00 hk. roving.
.139 hk.

Comparative Table.

	Standard Organization.			Long Draft Organization.		
	Size.	Pounds 10 Hours.	Spindles.	Size.	Pounds 10 Hours.	Spindles.
Spinning	22.00	.38	10,000	22.00	.38	10,000
Fine	4.50	1.85	2,097			
Intermediate	1.40	7.82	501	3.00	3.05	1,246
Slubber	.50	24.00	165			

In each of the various organizations given as illustrations in the previous pages, the development proceeds with two ideas in mind: first, that the draft for each operation should be within the usually prescribed limits of each operation and, second, that the size of the product should be reasonable for the machine making it. Often, the first trial for an organization is a very approximate affair and serves merely to give an idea of the drafts and sizes likely. From this as a basis, a more accurate layout is developed, in which sizes, of product are taken as fixed and the drafts necessary to produce these sizes are calculated.

For example, a very likely first approach for the 22s sheeting yarn might be as follows: Assume a spinning draft of 10 and roving drafts of 6, 5, and 4, respectively. 22 ÷ 10 = 2.20. Doubling this gives 4.40-hank fine roving. Using a draft of 6 on the fine frame gives 4.40 ÷ 6 = .73-hank, which, doubled, gives 1.46-hank intermediate roving. Using a draft of 5 on the intermediate, gives 1.46 ÷ 5 = .29, which, doubled, gives .58-hank slubber roving. A slubber draft of 4 gives .58 ÷ 4 = .145, or 57.5-grain sliver.

It is necessary to determine arbitrarily what sliver should be used. As 50 to 60 grains represents the common range, and as 60 gives higher production without appreciable reduction of quality, this would be a likely size to make on the drawing frame.

In the trial method spinning contraction was neglected, which means that the spinning draft would have to be enough greater to take care of it, if using 4.40-hank. Consequently, use a second trial, shifting to 4.50-hank. Using 5% spinning contraction gives 23.16s, which, divided by 2.25 (4.50-hank doubled), shows that a draft of 10.29 would be necessary on the spinning frame. As 60-grain sliver is heavier than our trial weight, it would seem best not to raise the 1.46-hank intermediate size but rather to coarsen it, so this trial is with 1.40-hank. Then, 4.50 ÷ .70 = 6.43 fine draft.

Then, to bring the slubber more in line with the heavier drawing sliver, change the .58 to .50-hank. This gives an intermediate draft of 1.40 ÷ .50/2 = 5.60. The slubber draft will be .50 ÷ .139 = 3.59.

It might seem that to give a more perfectly balanced set of drafts the intermediate roving should be 1.50-hank; and the slubber hank, .57. The drafts would then be 4.50 ÷ .75 = 6.00 fine, 1.50 ÷ .285 = 5.27 intermediate, and .57 ÷ .139 = 4.1 slubber.

The following table shows the sizes from these trials with the sizes actually used in two mills to produce yarns about this size.

	Trial		Sheeting	Tire
1st	2nd	3rd	22s	22.5s
22.0	23.16	23.16	23.16	23.93
4.40	4.50	4.50	4.50	4.50
1.46	1.40	1.50	1.40	1.50
.58	.50	.57	.50	.55
57.5	60	60	60	65

These trials show how any organization may be approached and worked out. At the same time the table indicates that two mills making similar counts may vary some from a theoretically perfect organization and yet not be radically different after all. Local mill conditions often limit the use of the theoretical organization, but it is surprising how many mills keep fairly close to it.

Organization for 23s Combed Tire Yarn.

Since the earlier days of automobile tire production, 23s yarn has been a standard tire yarn. Usually it is made into a cord 23/5/3. Much of this is woven with about two picks per inch as a means of holding the cords in place until the rubber coating will do so. In some instances, the warp is run through a machine which applies a rubber solution and so holds the cords together as a fabric without weaving.

Strength and elasticity are very important characteristics with a yarn of this sort. Much experimenting has been done to determine the best twists for spinning and twisting to produce the most desirable cords. About 19 twists per inch in the single yarn are considered necessary. This means a twist multiplier of about 4.00 and a spinning contraction of about 6%.

With the usual combination of twists used in the two twisting operations, it has been found that there is a slight elongation of the single yarns and the resulting strand is not exactly correct if 23s are spun. In one mill 22.5s was the exact count at the spinning frame to give a correct size for 23/5/3. Nevertheless, the yarns were called 23s.

The common arrangement is to use three roving operations, double roving at the spin-

Three Roving Operations.
Actual Count 22.5.

Double Roving in Spinning.
Spinning Contraction 6%.

Spinning contraction 6%	.94)	22.5	
Spinning draft	10.64)	23.93	
		2.25	
Spinning doublings		x 2	
Fine draft	6.00)	4.50	hk. Fine roving.
		.75	
Fine doublings		x 2	
Intermediate draft	5.50)	1.50	hk. Intermediate roving.
		.273	
Intermediate Doublings		x 2	
Slubber draft	4.25)	.545	hk. Slubber roving.
		.128	hk. or
		65	grain Second drawing.
Second drawing draft		5.54	
Second drawing doublings	6)	360	
		60	grain First drawing.
First drawing draft		5.50	
First drawing doublings	6)	330	
		55	grain Comb sliver.
Comb draft		60	
Comb noil 13%	.87)	3300	
Heads on comb	8)	3792	
		474	grain Ribbon lap.
Ribbon lapper draft		4	
Heads on ribbon lapper	4)	1896	
		474	grain Sliver lap.
Sliver lapper draft		2.33	
Sliver lapper doublings	20)	1100	
		55	grain Card sliver.
Card draft		94.5	
Card waste 5%	.95)	5200	
	437.5)	5475	
		12.5	ounce Picker lap.

Vertical Openers in Tandem
Bale Breaker

ning frame and two drawing operations.

This organization introduces combing which involves the sliver and ribbon lappers.

It should be quite clear that this same organization may be used for 23s carded yarn by simply omitting the lapping and combing operations. Note how closely this organization parallels the sheeting organization, although the cotton and the yarns are different in many respects.

The long draft modification for the 22.5's combed tire yarn would probably follow that just given for the sheeting yarn. With combed stock of a longer staple the spinning draft might be a little higher and very likely the drawn sliver would be about 60 grains, which could be obtained from the 55 grain combed sliver of the original organization. If modern combs were used, the sliver might reasonably be 60 grains from heavy laps. While the card would likely remain the same, the opening room would probably use blending feeders and one or two Buckley type openers.

Standard Draft Method for Organization.

One method of determining a reasonable series of drafts to use in making a yarn is based on a type of proportion between a series of "standard drafts" and the required drafts for the yarn in question. This involves first, establishing a "standard draft" for each operation. This draft is usually taken as an average draft for the operation, in this case they might be as follows:

Slubber	4	Spinning:
Intermediate	5	Single Roving 7 to 9
Fine	6	Double Roving 9 to 11.
Jack	7	

While some choose to carry this method back through drawing and carding, the organization in drawing and carding does not seem so directly connected with the changes in counts as to require including these operations. After all, the bulk of carding and drawing comes in the range of sizes between 50 and 60 grains and does not necessarily vary with the counts.

In using this system, it is necessary to conclude how many roving operations will be used and whether the yarn will be spun from single or double roving before starting the

solution for the necessary drafts. It is also necessary to know the grain sliver back of the slubber and the counts to be spun.

Using a definite illustration, let us assume a 22s yarn is to be spun from a 50 grain sliver using three roving operations and double roving in spinning.

The first step is to determine the "total standard draft" by multiplying together the "standard individual drafts" for the operations which are to be used. In this case take:- slubber 4, intermediate 5, fine 6, spinning 10.5.

4 x 5 x 6 x 10.5 = 1260 Standard Total Draft.

Next find the "actual total draft" to convert a 50 grain sliver to a 22s yarn, using the standard doublings. A 50 grain sliver is equivalent to a .167 hank roving. To reduce this to a 22s yarn requires $\frac{22}{.167} = 132$ effective draft. However, there are doublings of two ends each at the intermediate, fine and spinning frames, which means that in each case twice as much draft is required as when but one is fed. Then the "actual total draft" is

132 x 2 x 2 x 2 = 1056 Actual Total Draft.

The "standard total draft" is 1260, while the "actual total draft" is 1056. This means that the actual individual drafts are less than the standard individual drafts. However, as the total drafts are the results of multiplying together four separate drafts it is necessary to determine how much less than the standard drafts each actual individual draft shall be.

Of course, it would be possible to say, reduce the spinning draft until the "standard total draft" is the same as the "actual total draft". This defeats the very end toward which this work aims - the arranging of all the drafts so they are in the proper proportion to each other.

The ratio between the "actual total draft" and the "standard total draft" is 1056 to 1260, but this is not the ratio between the individual drafts as can be easily seen by finding this ratio and multiplying the standard drafts by it and then together.

To find the ratio between the standard individual drafts and the actual individual drafts it is necessary to find the root of the total drafts depending upon the number of drafts used. In this case, it is the 4th root. When the jack roving frame is used it will be the 5th root, while with two roving operations it will be the cube root.

In this case, then, the ratio is the 4th root of 1056 to the 4th root of 1260.

$$\frac{\sqrt[4]{\text{Actual Total Draft}}}{\sqrt[4]{\text{Standard Total Draft}}} = \frac{\sqrt[4]{1056}}{\sqrt[4]{1260}} = \frac{5.70}{5.96} =$$

.9562 Ratio Actual to Standard Individual drafts.

The following tabulation shows each operation with the standard draft, the actual draft and the size of product resulting from this organization.

Operation	Standard Draft	Actual Draft	Size
Spinning	10.5 x .9562 =	10.04	22.00 s
Fine	6.0 x .9562 =	5.74	4.39 hk.
Intermediate	5.0 x .9562 =	4.78	1.53 hk.
Slubber	4.0 x .9562 =	3.82	.64 hk.
Drawing			50. grains.

Organization for 40s to 60s balanced at 50s.

This organization illustrates a layout suitable for quality yarns such as are used for threads, voiles, organdies, lawns, muslins, shirtings and handkerchiefs.

The cottons commonly used for yarns of this kind are American Peeler and Egyptian, ranging from 1 3/16 to 1 3/8 inches in staple and from Strict Middling to Good Middling grade.

Four roving operations must be used with regular draft and double roving is common in spinning. The roving drafts are all rather low because this is the coarser end of the range of yarns requiring four processes of roving.

To obtain a high quality, combing is essential. Two possibilities are offered in combing, one suited to the newer types of combs using the heavier laps (700 grains) and one suited to the Heilmann type of comb using light laps. (525 grains)

Four Roving Operations.
Two Drawing Processes.

Double Roving in Spinning
Spinning Contraction 5%.

Spinning contraction 5% .95) 50.
Spinning draft 10.52) 52.63
5.00
Spinning doublings x 2
Jack draft 5.7) 10.00 hk. Jack roving.
1.75
Jack doublings x 2
Fine draft 5.6) 3.50 hk. Fine roving.
.625
Fine doublings x 2
Intermediate draft 5.0) 1.25 hk. Intermediate roving.
.25
Intermediate doublings x 2
Slubber draft 3.6) .50 hk. Slubber roving.
.1388 hk. or
60 grain Finisher drawing sliver.
Finisher draft 6
Finisher doublings 6) 360
60 grain Breaker drawing sliver.
Breaker draft 6
Breaker doublings 6) 360
60 grain Comb sliver.
Comb draft 60
Comb noil 14½% .8575) 3600
Heads in comb 6) 4200 8) 4200
700 525 grain Ribbon lap.
Ribbon draft 3.43 4
Heads on ribbon 4) 2400 4) 2100
600 525 grain Sliver lap.
Sliver draft 2.08 2
Sliver doublings 24) 1248 20) 1050
52 52.5 grain Card sliver.
Card draft 96 95
Card waste 7% .93) 5000
437.5) 5360
12.25 ounce Finisher lap.
13.00 ounce Breaker lap.

Buckley Opener
Bale Breaking Feeders

Long Draft Organization for 50's.

Long draft in spinning, only.

A mill making yarns similar to the 50's just considered, but 48's count, used the following organization after installing long draft in spinning. The spinning draft was not high for cotton of this staple. One roving operation was eliminated, which made it necessary to increase the roving drafts over these used in the original organization.

Three Roving Operation.
Two Drawing Processes.

Double Roving in Spinning.
Spinning Contraction 5%.

Spinning contraction 5%	.95	) 48.00	
Spinning draft	17.57	) 50.52	at the front roll.
		2.875	
Spinning doublings		2	
Fine draft	6.6	) 5.75	hk. Fine roving.
		.87	
Fine doublings		2	
Intermediate draft	5.6	) 1.74	hk. Intermediate roving.
		.31	
Intermediate doublings		2	
Slubber draft	4.5	) .62	hk. Slubber roving.
		.138	hk. or
		60.	grain Finisher drawn sliver.

Long draft in roving and spinning.

When this same mill tried an installation of long draft roving, they reduced the rovings operations to one. This required the roving frame to have a much higher draft than the spinning frame, one which was at the upper extreme of suggested practice.

One Roving Operation.
Two Drawing Operations.

Double Roving in Spinning.
Spinning Contraction 5%.

Spinning contraction 5%	.95	) 48.00	
Spinning draft	17.57	) 50.52	at the front roll.
		2.875	
Spinning doublings		2	
Roving draft	41.37	) 5.75	hk. Roving.
		.139	hk..or
		60	grain Finisher drawn sliver.

While this particular installation produced yarns as strong as those made using three processes of roving, the roving draft was very high. If the spinning draft should be increased to 20, it would still be necessary to use a roving draft of 37. This shows that 48's yarn is rather beyond the likely range for using one process of long draft roving. So, one proposal has been to use the regular slubber and then one long draft roving operation to produce the desired roving.

Two Roving Operations.
Two Drawing Operations.

Double Roving in Spinning..
Spinning Contraction 5%.

Spinning contraction 5% .95) 48.00
Spinning draft 17.57) 50.52 at the front roll.
2.875
Spinning doubling 2
Fine draft 23.00) 5.75 hk. Fine roving.
.25
Fine doublings 2
Slubber draft 3.6) .50 hk. Slubber roving.
.139 hk. or
60 grain Finisher drawn sliver.

While this organization is practical, from the processing point of view, it requires equipping a maximum number of roving spindles with long draft equipment and is expensive to install. Consequently, a more recent proposal would be to use long draft first followed by a standard fine or jack roving frame as shown be low.

Two Roving Operations.
Two Drawing Operations.

Double Roving in Spinning..
Spinning Contraction 5%.

Spinning contraction 5% .95) 48.00
Spinning draft 17.57) 50.52 at front roll.
2.875
Spinning doubling 2
Fine draft 5.0) 5.75 hk. Fine roving.
1.15
Fine doubling 2
Long draft roving 16.55) 2.30 hk. Long draft roving.
.139 hk. or
60 grain Finisher Drawing sliver.

With this arrangement, long draft equipment would be needed on only thirty percent as many spindles as in the previous case and so the machinery cost would be much lower.

Organization for 80s Combed Yarn.

Yarns from 60s to 120s are used in a variety of goods. Sheer fabrics, high quality goods and those where strength is a considerable factor but where weight must be kept down, all require this class of yarns. Mechanical fabrics offer a considerable field for these yarns.

Among the fabrics using these yarns are airplane and balloon fabrics, typewriter ribbons, insulation yarns, lawns, organdies, piques, fine sateens, muslins, marquisettes, handkerchief cloth, hosiery and laces.

With standard draft these yarns require four roving operations. They are spun from either single or double rovings. Two drawing operations are common and combing is a necessity.

Four Roving Operations.
Two Drawing Operations.

Double Roving in Spinning.
6.6% Spinning Contraction.

Spinning contraction 6.6%	.934)	80.00
Spinning draft	10.70)	85.50 at front roll.
		8.00
		x 2
Jack draft	7.00)	16.00 hk. Jack roving.
		2.29
		x 2
Fine draft	6.00)	4.58 hk. Fine roving.
		.76
		x 2
Intermediate draft	5.00)	1.52 hk. Intermediate roving.
		.30
		x 2
Slubber draft	4.00)	.60 hk. Slubber roving.
		.15 hk. or
		55 grain Second drawing sliver.
Second drawing draft		x 5.70
	6)	314
		52.3 grain First drawing sliver.
First drawing draft		x 5.73
	6)	300
		50 grain Comb sliver.
Comb draft		x 68.88
Comb noil 18%	.82)	3444
Comb heads	6)	4200
		700 grain Ribbon laps.
Ribbon lapper draft		x 4
Ribbon lapper heads	4)	2800
		700 grain Sliver laps.
Sliver lapper draft		x 2.06
Sliver lapper doublings	32)	1440
		45 grain Card sliver.
Card draft		x110
Card waste 6%	.94)	4950
	437.5)	5270
		12 oz. Picker lap.

Buckley Opener
Bale Breaking Feeders

Long Draft Modification.

The following organization is a modification of the preceding one showing how long draft in spinning may vary the sizes and drafts to use. This does not provide for long draft in roving. This is planned with the Controlled Draft Drawing, where the comb slivers are made into a lap on a doubler and then fed to the drawing frame as a narrow lap.

Spinning contraction 6.6% .934)80.00
Spinning draft 22.80)85.50
3.75
x 2
Jack or Fine draft 6.67) 7.50 hk. Jack or Fine roving.
1.125
x 2
Intermediate draft 5.62) 2.25 hk. Intermediate roving.
.40
x 2
Slubber draft 4.33) .80 hk. Slubber roving.
.185 hk. or
45 grain Drawing sliver.
Drawing draft (Controlled draft) x 17.77
Drawing doublings 16) 800
50 grain Comb sliver.

From here back follow the preceding organization.

When using long draft in both spinning and roving for this 80's yarn, it is impractical to try to produce 7.50 hank in one process of long draft roving. Consequently, following the reasoning illustrated in the organization for 50's, the 7.50 hank would be made on a jack frame using roving from a long draft roving frame. A likely organization follows.

Spinning contraction 6.6% .934)80.00
Spinning draft 22.80)85.50
3.75
x 2
Jack or Fine draft 5.00) 7.50 hk. Jack or Fine roving.
1.50
x 2
Long draft roving 18.00) 3.00 hk. Long Draft roving.
.167 hk. or
50 grain Drawing sliver.
Drawing draft 16
Drawing doubling 16) 800 grain Lap.
50 grain Comb sliver.

This arrangement gives very low drafts for the jack and long draft roving frames especially, compared with the spinning draft. If the spinning draft is cut to 17, the jack roving would be 10.00 hank. Keeping the draft of 5.00 would require 4.00 hank which would need a draft of 24.00 on the long draft frame. Or, if the jack draft is increased to 6.00, the roving would be about 3.60 hank, which would need a long draft of about 21.60. Any of these would be conservative drafts for each roving frame but the cost of production would be high because the rovings are all fine.

Using these frames with a draft of 30.00 on the long draft roving frame would give a 5.00 hank roving. This, with a jack draft of 6.00, would produce 15.00 hank and that, with a spinning draft of 20.00, would give 150's yarn. Thus, this arrangement of frames could cover the range of yarns from 80's to 150's without over-extending the drafts of the individual machines.

Print Cloth Organization.

Print cloth is a general name applied to several constructions, used for printed patterns. Trade papers list as many as 20 gray fabrics of this classification. They range from 27 to 44 inches in width and from 44 x 44 to 80 x 88 in construction. On the basis of 38½ to 39 inches wide, they vary from 4.00 to 8.20 yards per pound. Some of the listings are the same construction in different widths, e.g. a 31½"- 48 x 48 - 8.70 yard cloth is the same as a 36"- 7.75, a 38½"- 7.15 or a 44"- 6.40.

For a great many years, a print cloth of the 64 x 60 construction, 27 inches wide, weighing 7.60 yards per pound, of yarns about 28s warp and 36s filling was called a standard print cloth. In recent years, the same construction in 38½ inch width is one of the very common fabrics. (This same construction is woven 28"- 7.30, 32"- 6.00 and 36"- 5.75.) The counts of yarn vary some from 28s and 36s but these approximate the average counts used.

It seems very likely that this particular construction grew out of the natural limitations of the cotton used for the fabric. Ordinary inch cotton may be spun to counts up to 40s but the yarn is likely to be both uneven and weak. Somewhere in the vicinity of 28s was probably found to be the finest warp yarn which could be spun and maintain a reasonable strength. For the filling, strength was less important and so the cotton could be spun up to 36s and produce commercially acceptable uniformity.

A large quantity of this material is printed with a variety of colors giving the common percales, which are used in women's and children's clothes and men's shirts. Some print cloth is dyed to solid shades and some is bleached. These finishes are made up into night clothes and underwear, linings and shoe fabrics.

The cottons used range from 1 inch to 1 1/16 inches in grades ranging from Strict Low Middling to Strict Middling.

Three roving operations are used with regular draft. Some mills use single roving in spinning but the great majority use double roving.

Much of this cloth is produced in large mills, where volume is such that there is little handicap in keeping some rooms for warp exclusively, while others make only filling. In this organization, the attempt is to illustrate with a smaller mill, where there is considerable advantage in carrying the warp and filling stock through the same organization as far as possible.

The present problem is one using the same cotton for warp and filling treated exactly the same through opening, picking, carding and drawing and then dividing in the roving processes to permit proportional drafts in each lot of stock.

Three Roving Operations. Two Drawing Operations.		Double Roving in Spinning. Spinning Contraction, Warp 7%, Filling 5%.
Contraction	.93)30.00	.95)36.00
Spinning draft	11.52)32.26	11.31)37.90 at front roll.
	2.80	3.35
	x 2	x 2
Fine draft	6.20) 5.60	6.70) 6.70 hk. Fine roving.
	.90	1.00
	x 2	x 2
Intermediate draft	5.14) 1.80	5.70) 2.00 hk. Intermediate roving.
	.35	.35
	x 2	x 2
Slubber draft	4.20) .70 hk. Slubber roving.	
	.167 or	
	50 grain Second drawing sliver.	
Second drawing draft	x 6	
Second drawing doublings	6) 300	
	50 grain First drawing sliver.	
First drawing draft	x 6	
First drawing doublings	6) 300	
	50 grain Card sliver.	
Card draft	x 100	
Card waste 5%	.95) 5000	
	437.5) 5263	
	12.03 oz. Picker lap.	

Horizontal Opener
Vertical Opener
Buckley Opener
Blending Feeders (or Bale Breaker)

Print Cloth Long Draft Organization.

If long draft spinning is used with drafts of about 16, the fine roving needed would be about 4.00 hank for 30's warp and 4.60 hank for 36's filling. These rovings are too fine to be made on the usual slubber and intermediate frames. Thus, the advantage would be gained in making coarser fine and intermediate rovings, as shown for the 22's sheeting yarn. If the production for 5.60 hank is 1.36 pounds per spindle, while the production of 4.00 hank is 2.18 pounds per spindle, but 63 percent of the original fine spindles would be needed. The saving at the intermediates would probably be somewhat less. The saving of the filling fine spindles would be about 41%.

If long draft is used for both spinning and roving, the 4.00 hank could be made in one operation. A likely organization for such a condition would be as follows.

One Roving Operation.
Two Drawing Operations.

Spinning contraction	.93) 30.00	
Spinning draft	16.13) 32.26	
	2.00	
	2	
Roving draft	24.00) 4.00	
	.167 or	

Double Roving in Spinning.
Spinning Contraction, Warp 7%, Filling 5%.

.95) 36.00	
16.48) 37.90	
2.30	
2	
27.55) 4.60	
.167 or	

50 grain Second Drawing sliver.

In this modernization, the fine roving spindles needed may be reduced 37% and 41%, respectively, as explained above because of the long draft in spinning. Using long draft on the roving frame, makes it possible to eliminate two processes of roving and do all the roving on one frame. This change reduces the number of roving operatives necessary. While the number of frames is considerably reduced, the floor space needed is not reduced as much as might be expected because each roving frame has cans of drawn sliver behind it. Also, there must be spare floor enough to collect full cans for re-creeling and for moving away empty cans.

Coarse Sheeting Mill Organization.

There is considerable variety in the coarser sheetings, especially as to weight per yard. This is due partly to a variety of constructions and partly to a variety of counts. The weights vary from 2.85 to 5.00 yards per pound and the counts vary from 10s to 24s.

Some mills make all the common weights and constructions which involves spinning a great variety of coarse counts. Inasmuch as the volume on various lines shifts from time to time, an effort is made to make as many yarns from one set of rovings as possible. This example is intended to illustrate how this is done.

The following tabulation shows a series of the common coarser constructions and the price per yard, gray goods, spot southern, F.O.B. mill. An additional column shows the average counts of the yarns as found by the following formula.

Average counts =

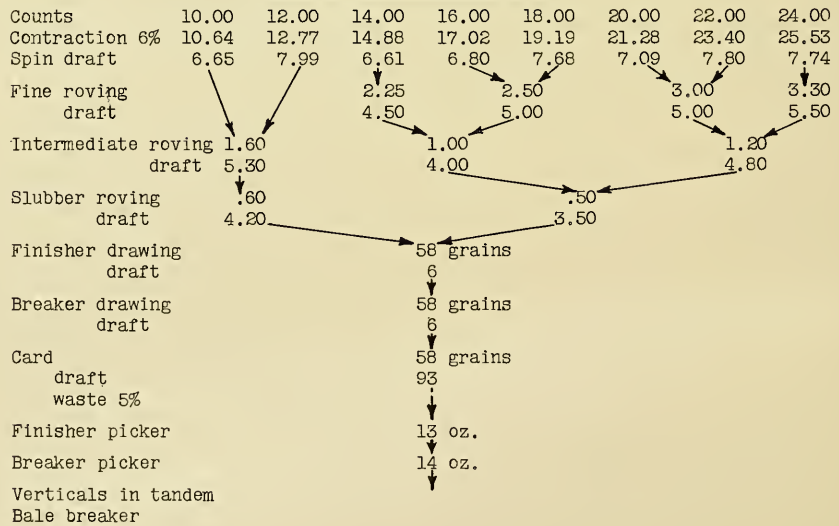
$$\frac{\text{(Ends + Picks) x Inches wide x Yards per pound}}{\text{(1.00—percent takeup) x 840}}$$

Coarse Sheetings.

Construction			Price.	Avg. Counts
31"	48 x 48	5.00	5 3/4¢	19
36"	"	5.00	5 3/4¢	22
37"	"	4.00	7 ¢	18
36"	"	3.00	8 3/4¢	13
40"	"	2.85	9 1/8¢	14
40"	"	2.50	10 5/8¢	12
40"	60 x 56	3.60	8 1/2¢	21
40"	64 x 68	3.15	9 3/4¢	21
36"	56 x 60	4.00	7 1/4¢	21
New York Spot Cotton (7/6/1935)				10.75¢

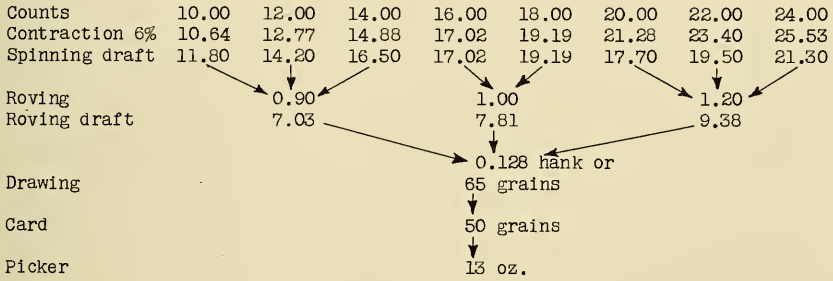
The values of average counts give an approximate idea of the counts used in each cloth. Of course, if the warp is a little heavier than the average figure, the filling must be a little lighter than the average. Thus it is demonstrated that the counts may easily range anywhere from 10s to 24s.

In this case, warp counts of 10s, 14s, 18s and 22s, with filling counts of 12s, 16s, 20s and 24s are assumed. The organizations may be slightly changed to get any counts in between. To simplify the layout, an average contraction of 6% is assumed for all counts. All are spun from single roving with two roving operations for 10s and 12s and three roving operations for the others.


Counts 10.00 12.00 14.00 16.00 18.00 20.00 22.00 24.00
Contraction 6% 10.64 12.77 14.88 17.02 19.19 21.28 23.40 25.53
Spin draft 6.65 7.99 6.61 6.80 7.68 7.09 7.80 7.74
Fine roving 2.25 2.50 3.00 3.30
draft 4.50 5.00 5.00 5.50
Intermediate roving 1.60 1.00 1.20
draft 5.30 4.00 4.80
Slubber roving .60 .50
draft 4.20 3.50
Finisher drawing 58 grains
draft 6
Breaker drawing 58 grains
draft 6
Card 58 grains
draft 93
waste 5%
Finisher picker 13 oz.
Breaker picker 14 oz.
Verticals in tandem
Bale breaker

Long-Draft Modification: A mill making yarns of this general type was recently remodeled with long draft for both spinning and roving. The roving frames used were 10 x 5 intermediates arranged with slubber creels and long draft. In this mill, counts up to 14s were spun from 0.90-hank roving, 14s to 20s were spun from 1.00-hank roving, and yarns above 20s were spun from 1.20-hank roving. All these rovings were made from 65-grain drawing sliver, 50-grain card sliver, and 13-oz. laps.

While this mill did not spin exactly the counts used here, the organization shown has been adapted to give the counts used in the regular draft organization.



Osnaburg Organization: There is considerable variation in osnaburgs, depending upon the use to which they are put. The osnaburgs going into cheap bagging are frequently quite dirty. These frequently have a percentage of willowed beater seed and fly in addition to card strips and some new cotton. The cleaner varieties, such as are used for shoe fabrics and rubber fabrics, will not have the beater seed and will be much cleaner.

There is a considerable range of constructions for osnaburgs, and the counts may b from as low as 5s to as high as 10s.

The sample used as a basis for this example was a 40-in., 2.56-yd., 32x28 construction made with 6.75s warp and 8.00s filling. The o ganization is laid out for the coiler waste system.

One Roving Operation.
No Drawing Process.

Single Roving in Spinning.
8% and 7% Spinning Contractio

	Warp.		Filling.
Spinning contraction 8%	.92) 6.75	7%	.93) 8.00
Spinning draft	5.63) 7.33		6.15) 8.60
Slubber draft	3.94) 1.30		4.20) 1.40
	.333-hank or 25-grain finisher-card sliver		
Finisher-card coilers	x4		
	100-grain delivered at finisher		
Finisher-card draft	x88.3		
Finisher-card waste 8%	.92) 8,830		
160 breaker-card slivers*	160) 9,600		
	60-grain breaker sliver		
Breaker-card draft	x105		
Breaker-card waste 10%	.90) 6,300		
	7,000-grain or 16-oz. picker lap.		

*Four doubler laps of 40 ends each.

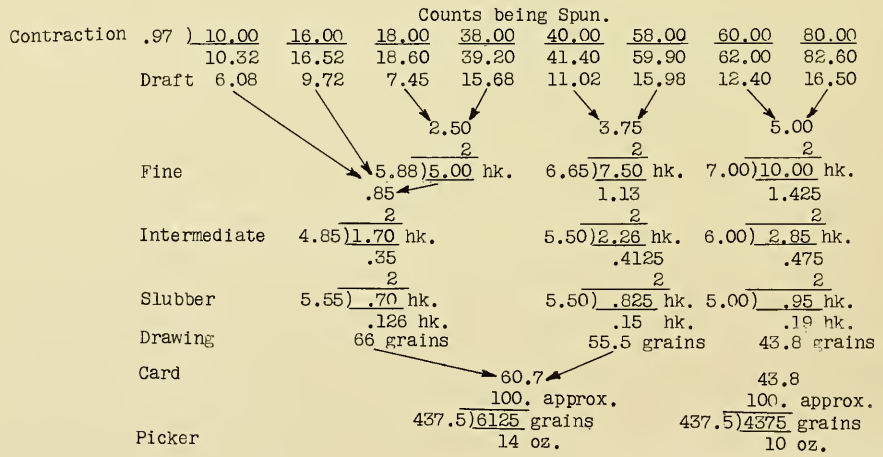
Staple Rayon Organizations.

When cotton machinery is used to process staple rayon fibers, the organizations may be exactly the same as for cotton yarns. As the staple rayon is clean, the wastes in opening, picking and carding are lower than for cottons, even when long staple, high grade cotton is used. Drafts follow quite closely those used for cotton. Spinning twists for rayons usually run considerably less than for cotton because the maximum for rayon yarns seems to be obtained with a multiplier of about 3.00.

In the early days of staple fiber, spinners found it necessary to use some treatment to improve the processing characteristics. Today, the staple fiber manufacturers apply some "finish" to their fibers and caution against its removal before processing. These "finishes" have improved the processing qualities of rayon until the processing problems have been largely eliminated. Much of today's rayon staple can be run on cotton machinery "just like cotton".

The following table represents the organizations given by one mill, well before World War II, for processing 1-1/2 Denier, 1-1/2 inch Viscose fiber.

Note that the 10's and 16's were made with two roving operations, while all other counts were spun using three roving operations. Note that the 60's and 80's have a different organization all the way through, originating in a 10 oz. lap and 43.8 grain sliver. All slubber sizes are "on the light side". All roving drafts are within the accepted range but slubber drafts are all rather high. Spinning drafts show a considerable range, from 6.08 to 16.50. However, the range is probably the result of the varying needs for such a wide range of counts.



Acetate Organization.

A recent production of 18's yarn from 3 Denier, 1-1/2 inch staple Acetate fiber gave a very good product, with the following organization.

Two Roving Operations.
Two Drawing Operations.

Double Roving in Spinning.
Spinning Contraction 3%.

Spinning contraction 3%	.97)	18.00	
Spinning draft	16.87)	18.56	at front roll.
		1.10	
Spinning doublings		2	
Intermediate draft	5.87)	2.20	hk. Intermediate roving.
		.375	
Intermediate doublings		2	
Slubber draft	5.00)	.75	hk. Slubber roving.
		.15	hk. or
		55	grain Second Drawing sliver.
Second Drawing draft		6	
Ends up	6)	330	
		55	grain First Drawing sliver.
First Drawing draft		6	
Ends up	6)	330	
		55	grain Card sliver.
Card draft		100	
Card waste 3%	.97)	5500	
	437.5)	5670	
		13	oz. Picker lap.

Wool Organization on Cotton Machinery:

Previous to World War II, some mills were making considerable progress in processing wool fiber on the cotton system. Much of the early work was with cut worsted top and this still continues for some yarns. However, by extending the length of roll stands and increasing roll diameters, considerable cotton machinery has been modified to process short staple worsted top directly, without any cutting. This has been called the "American System" by some worsted men.

The worsted top for this work is commonly bought weighing about 250 grains per yard. This is reduced, with no doubling, in the first drawing operation to around 50 grains per yard. The intermediate and finisher drawings, using 5 or 6 ends up, will also produce about 50 grains sliver. Then, using one operation of long draft roving, hanks from 1.30 to 4.00 (cotton sizes) may be produced. Using long draft equipment on the spinning frame and selecting the finer wool tops, it is possible to spin up to 36's worsted size.

Following the proposals of the Whitin Review for March 1947, the organization for an 18.8's yarn, cotton size, which would be equivalent to a 28's worsted size, would be as follows.

One Roving Process.
Three Drawing Processes.

Double Roving in Spinning.
Spinning Contraction 3%.

Spinning contraction	.97) 18.80	
Spinning draft	12.93) 19.40	at front roll.
	1.50	
Spinning doubling	2	
Roving draft	18.00) 3.00	hk. Roving.
	.167	hk. or
	50 grain	Finisher Drawing.
Finisher Drawing draft	5	
Ends up	5)250	
	50 grain	Intermediate Drawing.
Intermediate drawing draft	5	
Ends up	5)250	
	50 grain	Breaker Drawing.
Breaker drawing draft	5	
Ends up	1)250	
	250 grain	Top.

Balancing Machinery.

Determination of the amount of machinery necessary to keep a mill in balance requires that certain data must be known or assumed as a basis for the calculations.

The simplest form to use for collecting these data and calculations is shown in the following illustrations. The first column shows the operations used for the particular organization. The second column shows the size produced in each of these operations. The figures in these two columns are taken from the organizations worked out in the first section of these notes. The third column shows the waste in each operation. Where a mill has handled the stock involved and knows from experience what the wastes will be, actual figures are used. Otherwise, it is necessary to estimate the percentages of waste.

The fourth column shows the percentage of stops for each operation. Figures for this column are taken directly from the machine builders' tables. If the stops in a mill do not agree with the catalog figures, it will be necessary to substitute the actual stops found under mill conditions.

The fifth column shows the pounds produced at each operation in order that the following processes will have just the right amount of stock to keep them going. When balancing a given number of spindles, it is necessary to determine the pounds produced by these spindles and then to work back to the pounds for each process. If it is necessary to calculate the equipment for a given poundage of yarn, the calculation is just that much simpler.

The sixth column shows the pounds produced by one unit (spindle, delivery, machine, etc.). This may be actual production as found by experience or a calculated figure. In this case, the figures are taken from machine builders' catalogs and show the production per 10 hours, with an allowance made for stops as shown in the fourth column.

While 10 hours is hardly a working day at the present, the production per 10 hours is a very convenient figure. Pointing off one place gives the pounds per hour or multiplying by fou gives the pounds for a 40 hour week.

The seventh column is calculated from columns five and six, and indicates the number of units needed when the pounds required are as in column five and the unit production is as in column six. The eighth column shows the speed of the machines necessary to give the pro ductions shown in column six. The ninth column shows how the total units are divided into machines and is particularly important in spinning, roving and drawing. The tenth column gives such details as serve to show the machine selected for the production in column six. The eleventh and twelfth columns show the floor spa required by the machines, without alley space. Machinery for 13's.

The first illustration is a mill having 20,000 spindles to make 13s warp yarn, as shown in the second organization. The same principle followed here will serve to find the equipment for a mill to make the 6s organization or the 2 of the sheeting organization.

For convenience, most of the waste figures have been kept in whole numbers. Probably 3% spinning waste is fairly high; but, when the roving left on the bobbins from the creel is co sidered, it is not impossible. Many mills keep their roving waste between 0.5 and 0.75% per op ation, but in this case the waste for both proc esses has been taken as 1% for convenience in f uring.

In this solution, the stops, speeds, and suggestions as to details given in the catalogs have been followed. Using 20,000 spindles at 0.54 lb. per spindle produces 12,800 lb. of yarn. This figure in only 97% of the roving needed from the intermediates; hence, 12,800 ÷ 0.97 = 13,196 lb. of intermediate roving. Then 13,196 ÷ 0.99 = 13,329 lb. of slubber roving needed. Continuing this procedure, it is possible to complete column five, showing the pounds of stock each operation must produce.

Knowing the total pounds needed, it is then necessary to find the units required in each operation. This is possible only after determining the pounds each unit will produce. This necessitates the selection of a size of frame (in the case of a new installation) and a speed suitable for the product. The selection hinges on the quality of the goods to be produced and the cost at which they must be delivered. This means that the same counts may be made quite differently for different products and that personal judgment has considerable to do with the selection of these items.

For the 13s in question, it is very likely that 9x4-1/2 intermediates and 12x6 slubbers would be selected. Catalog speeds and productions are shown.

In drawing stock of the staple commonly used for this yarn, it is desirable to have small drawing rolls, either 1 or 1-1/8 in. in diameter. Metallic rolls are very common for this type of work; hence the selection of 1-1/8-in. metallic rolls. The roll speed of 300 r.p.m. is fairly conservative, which would make it possible to go slightly faster if the organization were ever altered to run 50-grain sliver.

Ten revolutions of the card doffer per minute is a fairly average speed. If the speed is reduced, costs will rise; but, on the other hand, higher carding speeds may alter the quality adversely. Picker calender-roll speeds are generally given less notice than the pounds produced. While earlier practice tended to keep

MACHINERY FOR 13's Warp Yarn SIZE OF MILL 20,000 Spindles

1 OPERATION	2 SIZE	3 WASTE %	4 STOPS %	5 TOTAL POUNDS	6 LB. PER UNIT	7 UNITS	8 SPEED	9 MACHINES	10 DETAILS	11 LENGTH	12 WIDTH
Spinning	13	3	10	12,800	0.64	20,000	8,000	84-240	4"gg 2⅛"ring	42'-6"	3'-3"
Inter.	1.85	1	11	13,196	5.51	2,395	950	20-120	9 x 4½	38'-3"	3'-6½"
Slubber	0.55	1	19	13,329	21.23	628	650	10-64	12 x 6	29'-11"	6'-10"
Drawing	55	0.5	20	13,464	137	98.3	300	2-4x6 2-3x6+2x4	1⅛" met.	40'-3" 44'-8¼"	5'-11"
Carding	55	7	10	13,512	120	112.5	10	113	27"	10'-6"	5'-4"
Picking	15	1	10	14,529	3,580	4.06	8.99	4	—	49'-0"	6'-8"
Horizontal	—	0.5	—	14,689	15,000	1	—	1	—	10'-6"	6'-6"
Vertical	—	2	—	14,769	15,000	1	—	1	—	9'-8"	5'-7"
Vertical	—	1	—	15,088	15,000	1	—	1	—	9'-8"	5'-7"
Bale Breaker	—	4.5	—	15,248	15,000	1	—	1	—	33'-9"	6'-10"
In Bale	—	—	—	15,966							

picker productions (especially finishers) not over 3,000 lb. per 10 hour, today's tendency is to produce more than that, say 3,500 lb. per 10 hour, on the single-process picker. As opening equipment will ordinarily handle up to 20,000 lb. in 10 hour, there is no problem.

Column seven, the units needed, is calculated by dividing the pounds per unit (column six) into the total production needed (column five); e.g., intermediate, 13,196 ÷ 5.51 = 2,395 spindles.

In the case of a new installation, dividing up the units into frames involves more judgment, especially with consideration of the mill dimensions to be used and the arrangement of the machines in the mill. When following the older scheme of arranging spinning frames lengthwise of the mill, the length depends upon practical items of a mechanical and operating nature. If spinning is to be arranged across the mill, the length must conform to the space available.

In this illustration, the mill has been taken as having four 25-ft. spans. From the catalog on frames of 4-in. gage, it is found that a 240-spindle frame takes 42 ft. 6 in., which leaves space enough in a 100-ft. mill for alleys with two frames across; hence, 84 spinning frames of 240 spindles each.

Considering a similar arrangement for intermediates brings up the question of the spindles per frame. A frame having 126 spindles has a length of 40 ft. However, this would mean 19 frames and, if frames are still worked in pairs, would make an awkward arrangement. Using frames with 120 spindles, which are 38 ft. 3 in. long, requires 20 frames.

Slubbers are quite likely to be arrange differently than other roving frames and are generally in pairs. Hence, they do not need to correspond in length to the other frames. Slubbers with 76 spindles are 34 ft. 11 in. long, and it would take more than eight of them.

Therefore, nine would be required. If slubbers were run in threes, this would work out nicely; but where slubbers are run in pairs this would be awkward. In this case frames short enough to require ten would giv five pairs. Each slubber with 64 spindles would be 29 ft. 11 in. long.

Drawing frames are usually arranged across the mill, and so the lengths of frame should be arranged to fit. In this case, by running the frames at 310 r.p.m., 96 deliver ies would be enough; but keeping the speed a 300 r.p.m. would require 100 deliveries as the most suitable set-up. One hundred deliv eries may be arranged in several combination but, in this case, the following seems as pr tical as any:

Two frames of four heads, each having s deliveries; two frames of three heads, each having six deliveries; and two frames of two heads, each having four deliveries. The fir frames are 40 ft. 3 in. long, while the seco frames are 44 ft. 8-1/4 in. long. One frame each of the above may be arranged across the mill and still leave plenty of alley space.

Machinery for 22's Sheeting Filling.

The 22s sheeting filling is representative of the average count of yarn spun in the United States. When using regular draft in roving and spinning, 22s require three processes of roving. Two drawing processes are quire common for this count.

The following table is figured on the basis of 20,000 spindles, thus giving a ready comparison with the 13s equipment. Note that the production per unit in spinning is only 0.38 lb. and the total is only 7,600 lb., which is about 60% of the corresponding figure for 13s. This reduces the quantity of material to be processed in all the operations.

In this case, the roving wastes have been taken in fractional percentages as they are likely to occur in the mill. Catalog figures for stops have been used. The opening machinery will be running with a very light load, but there is no way of getting the opening without one complete set of machines. Probably this same equipment could handle enough stock for 30,000 spindles on this count.

As has been pointed out in the organizations, using long draft in spinning and making coarser fine and intermediate rovings reduces the number of spindles necessary on the two operations very materially. Finally, if long draft is used in both roving and spinning, all the slubber and intermediate spindles are eliminated. However, by observing the number of machines in each operation, it can be seen that these two operations do not involve even one-half the frames used and the saving is not so great as at first appears. When cans are put up back of an 8x4 roving frame, the creeling is very much reduced, which makes a saving in labor not apparent in the calculations. In the lower part of the table, the two optional possibilities of long draft are shown.

MACHINERY FOR 22s Sheeting Filling SIZE OF MILL 20,000 Spindles

1 OPERATION	2 SIZE	3 WASTE %	4 STOPS %	5 TOTAL POUNDS	6 LB. PER UNIT	7 UNITS	8 SPEED	9 MACHINES	10 DETAILS	11 LENGTH	12 WIDTH
Spinning	22	2	12	7600	0.38	20,000	7925	70-288	$3\frac{11}{99}$ 1⅝ ring	38'-6"	3'-3"
Fine	4.50	0.5	7	7755	1.85	4192	1150	28-152	7x3½	36'-6"	3'-4"
Inter.	1.40	0.6	17	7794	7.82	996	950	10-102	9x4½	33'-0"	3'-6½"
Slubber	0.50	0.4	22	7841	24.00	327	650	6-56	12x6	26'-7"	6'-10"
Drawing	60	0.5	20	7873	193	40.8	300	1-4-6 / 1-3-6	1⅜" met.	40'-3" / 30'-5¾"	5'-11"
Drawing	60	0.5	20	7913	193	41.0	300	1-4-6 / 1-3-6	1⅜" met.	40'-3" / 30'-5¾"	5'-11"
Carding	60	6.	10	7953	131	60.7	10	61	—[1]	10'-6"	5'-4"
Picking	15	1	10	8460	3470	2.4	8.72	3	—	49'-0"	6'-8"
Buckley		0.6	—	8553	15000	1	—	1	—	7'-10"	6'-10"
Buckley		1.0	—	8609	15000	1	—	1	—	7'-10"	6'-10"
Vertical		1.5	—	8702	15000	1	—	1	—	9'-8"	5'-7"
Bale Breaker		4.9	—	8841	15000	1	—	1	—	22'-0"	6'-10"
				9297							
Fine	3.50	—	10	7755	2.61	2971	1150	20-152	7x3½	36'-6"	3'-4"
Inter.	1.20	—	21	7794	9.47	823	950	8-102	9x4½	33'-0"	3'-6½"
Inter.	3.50	—	10	7755	2.61	2971	1150	20-152	7x3½	36'-6"	3'-4"

Machinery for 23's Tire Yarn.

The organization for 23s tire yarn is the first to introduce combing, with the accompanying operations of the sliver lapper and the ribbon lapper. The organization is based on the use of light laps, as is necessary for the Heilmann type of comb, usually Whitin D-2 in this country. While these combs are not being sold today, there is such a predominating quantity of them still in use that they should not be neglected in a study of this sort.

The general procedure here is exactly the same as in the calculations for the 13s and 22s machinery. This organization is so much like that for the sheeting filling that the only discussion given is for such operations as differ from the 22s.

Cotton used for this quality of yarn would be of a fairly high grade, and two opening machines would supply enough cleaning. Slow carding is a prerequisite for good combing. Lapper speeds have been taken as 90 r.p.m. in each case and may be increas to 100. However, this would not make much difference in the equipment needed.

The D-2 comb, at 120 nips per minute, i near its maximum speed, but still gives a ve low production. If some of the newer combs were to be used, the production would be increased about 50% which means that only abou 48 combs would be necessary.

As combed cotton for this work would pr ably be from 1-1/8 to 1-3/16 in. long, 1-3/8 in. drawing rolls would be practical. Commo rolls have been selected because they are mo likely to be found on combed work than on carded work. The use of common rolls reduce the pounds per delivery to about 150, as com pared with 193 pounds in the 22s organizatio

Note that the pounds per spindle are th same as for the 22s, even though the spindle speed in this case is 1,000 r.p.m. higher. This is because the twist is so much greater in the tire yarn.

Making the yarns into the finished cord

MACHINERY FOR *22.5s Tire Yarn* SIZE OF MILL *20,000 spindles*

1 OPERATION	2 SIZE	3 WASTE %	4 STOPS %	5 TOTAL POUNDS	6 LB. PER UNIT	7 UNITS	8 SPEED	9 MACHINES	10 DETAILS	11 LENGTH	12 WIDTH
Spinning	22.5	2	9	7,600	0.38	20000	9075	80-252	3¾gg 2"R	41'-10"	3'-3"
Fine	4.50	1	7.4	7,755	1.85	4,192	1,150	26-160	7 x 3½	38'-3"	3'-4"
Inter.	1.50	1	16	7,833	7.20	1,088	950	10-114	9 x 4½	36'-6"	3'-6½"
Slubber	0.55	1	20	7,912	21.23	373	650	6-64	12 x 6	29'-11"	6'-10"
Drawing	65	0.5	20	7,992	151	52.9	280	3-3-6	1⅜" Conn.	30'-5¾"	5'-11"
Drawing	60	0.5	20	8,032	150	53.5	300	3-3-6	1⅜" Conn.	30'-5¾"	5'-11"
Comb	55	15	5	8,072	112	72.1	120	72	D-2	17'-5"	3'-6"
Ribbon Lapper	474	1	25	9,497	1.197	7.94	90	8	—	12'-0"	4'-5¾"
Sliver Lapper	474	1	25	9,593	1,197	8.01	90	8	—	10'-9"	4'-3"
Card	55	7	10	9,690	86.5	112	7	112	27" Doffer	10'-6"	5'-4"
Picker	12.5	2	10	10,419	3,130	3.3	9.45	4	—	49'-0"	6'-8"
Vertical	—	3		10,651	15,000	1	—	1	—	9'-8"	5'-7"
Vertical	—					1	—	1	—	9'-8"	5'-7"
Bale Breaker	—	5		10,998	15,000	1	—	1	—	33'-9"	6'-10"
				11,577							
Winding	22.5	1	35	7,524	24.3	310	1,200	1-216 1-144	Type C	62'-9¾" 48'-5"	9'-0"
Warping	22.5	1	44	7,449	6,400	1.2	900	2	400 End VW	25'-0"	18'-4"
Twisting (5 Ply)	22.5/5	1	8	7,374	1.33	5,545	5,700	35-160	5gg 3½ R	35'-9½"	3'-3"
Twisting (3 Ply)	22.5/3/3	1	10	7,300	5.00	1,460	3,150	12-124	7"gg 5½"R	38'-7½"	3'-6"

involves winding and twisting operations. Ordinarily, the single yarns are spooled or would to get long lengths on one package, and then the single ends--enough for half a frame in most cases--are wound on a section beam.

A beam twister makes the first strand, five ply, on spools about 3x6 inches. In some cases, these spools go directly onto the pins of the second twister creel; in other cases, several spools are rewound into one package to give a long length in the second twister creel. The second twister, making three ply (of the five ply), often uses a spool 5x8 inches.

The calculations for the winding and warping are based on high-speed machines. Both twisting operations are calculated on the basis of ring twisters.

Print Cloth Machinery.

This print-cloth mill is taken as an illustration of a complete layout to produce gray cloth. As this type of fabric is produced in enormous quantities, and as the counts involved are medium to fine, it is about as typical of the entire industry as any single organization can be.

The problem is one of balancing the equipment of a 50,000-spindle unit. In order to lay the necessary groundwork of detail, the first portion of the calculations considers the cloth and the layout for the warp in warping and slashing. This work is necessary as a means of finding the ends per beam, a figure which must be known in determining the production of these operations.

The details are worked out on the assumption that the cloth is 38-1/2 in., 64x 60, 5.35-yd., gray goods; that the warp count is 30s and the filling count is 36s; that 50 yards is the desired length of cut for the gray goods; that a loom beam will hold about 150 pounds of warp yarn; that an average slashing gives 6% size; that a section beam will hold in the vicinity of 400 ends and a weight of about 420 lb.; and that the take-up in the cloth is 6% for the warp and 5% for the filling.

Body ends warp 38 x 64 = 2,432
Selvage ends 40
Total warp ends 2,472

50-yd. cut with 6% take-up gives:

50 ÷ 0.94 = 53.2 yd. warp per cut.

With 150 pounds on a loom beam, including 6% slasher size:

$$\frac{0.94 \times 150 \times 30 \times 840}{2,472} = 1,437.4 \text{ yd. possible}$$

on loom beam. 1,437.4 ÷ 53.2 = 27.02 cuts.

An even 27 cuts per loom beam gives 1,436.4 yd.

Six section beams of 412 ends each are required for 2,472 ends. One or two ends may be added to take care of breakage, but these will be neglected here. If a section beam holds 42 pounds with 412 ends, the yardage will be:

$$\frac{420 \times 30 \times 840}{412} = 25,500 \text{ yd.}$$

$$\frac{25,500}{1,436.4} = 17.78 \text{ loom beams per section bea}$$

Using an even 17 loom beams gives:

17 x 1,436.4 = 24,418.8 yd. per section beam.

To determine the division of the 50,000 spinning spindles in the correct proportion to produce the proper quantities of warp and filling, it is necessary to determine the proportion of warp and filling in the cloth and to make allowance for the losses from spinning through weaving. Then, these figures used with the pounds produced per spindle will give the percentages of warp and of filling spindles.

Weight of yarn in one yard of cloth.

Warp, 6% take-up.

$$\frac{2,472 \times 36}{0.94 \times 36 \times 30 \times 840} = 0.1044 \text{ lb. warp.}$$

Filling, 5% take-up.

$$\frac{60 \times 38\text{-}1/2 \times 36}{0.95 \times 36 \times 36 \times 840} = 0.0804 \text{ lb. filling}$$

Total 0.1848 lb. per yd.

To make allowance for the losses after spinning, the following waste percentages have been assumed: warp-winding 1%, warping 0.5%; slashing 1%, weaving 0.5%; and filling-weaving 1%.

Weight of yarn to be spun for one yard of clot

$$\text{Warp } \frac{0.1044}{0.99 \times 0.995 \times 0.99 \times 0.995} = 0.107 \text{ lb. warp}$$

$$\text{Filling } \frac{0.0804}{0.99} = 0.0812 \text{ lb. filling.}$$

ivision of Warp and Filling Spindles.

Warp production = 0.22 lb. per spindle per 10 hr.

illing production = 0.21 lb. per spindle per 0 hr.

Notice that while the filling twist is lower han the warp twist, the lower spindle speed and iner counts offset the higher front-roll speed n such a way that the production of 36s filling s almost equal to the production of 30s warp.

pindles for One Yard of Cloth.

Warp 0.1076 ÷ .22 = 0.489 warp spindles

illing 0.0812 ÷ .21 = 0.387 filling spindles

0.876 total

er cent warp spindles $\frac{0.489}{0.876}$ = 55.8%

x 50,000 = 27,900

er cent filling spindles $\frac{0.387}{0.878}$ = 44.2%

x 50,000 = 22,100

The calculations for the amount of machinery ecessary to balance a 50,000-spindle mill pro- ucing print cloth have been made operation by peration. Each process has been completed efore going on to the next. This arrangement hows no more data than the tabulated form, but t does show how the various calculations are ade and how one figure is obtained from the receding figures. The calculations are based n high-speed spooling and warping.

Warp Spindles, 27,900 -- Filling Spindles, 2,100.

Spinning, Warp: 30s, 0.22 lb. per 10 hours -- 3-1/2 in. gage @ 9,525 r.p.m.

27,900 × 0.22 = 6138 lb.

27,900 ÷ 240 = 116 frames + 60 spindles.

37 ft. 6 in. long by 3 ft. 3 in. wide.

Spinning, Filling: 36s. 0.21 lb. per 10 hours -- 3 in. gage @ 8,175 r.p.m.

22,100 × 0.21 = 4641 lb.

22,100 ÷ 272 = 81 frames + 68 spindles.

36 ft. 6 in. long by 3 ft. 3 in. wide.

In order to avoid fractional spinning frames, this illustration assumes that the mill will have 116-240 spindles warp frames having 27,840 spindles and 81-272 spindle filling frames having 22,032 spindles, making a total of 49,872 spindles. The poundage of yarn spun on these frames will be:

Warp 6,125 lb.

Filling 4,627 lb.

Fine, Warp: 5.60 hank, 1.36 lb. per 10 hours -- 7 × 3-1/2, 1,150 r.p.m.

6,125 ÷ 0.98 = 6,250 lb.

6,250 ÷ 1.36 = 4,598 spindles.

4,598 spindles ÷ 152 = 31 frames.

36 ft. 6 in. long by 3 ft. 4 in. wide.

Fine, Filling: 6.70 hank, 1.08 lb. per 10 hours -- 7 × 3-1/2, 1,150 r.p.m.

4,627 ÷ 0.98 = 4,721 lb.

4,721 ÷ 1.06 = 4,454 spindles.

4,454 spindles ÷ 152 = 29 frames.

36 ft. 6 in. long by 3 ft. 4 in. wide.

Intermediate, Warp: 1.80 hank, 5.70 lb. per 10 hours ; - 9 × 4-1/2, 950 r.p.m.

6,250 ÷ 0.99 = 6,313 lb.

6,313 ÷ 5.70 = 1,108 spindles.

1,108 spindles ÷ 108 = 11 frames.

34 ft. 9 in. long by 3 ft. 6-1/2 in. wide.

Intermediate, Filling: 2.00 hank, 4.94 lb. per 10 hours -- 9 × 4-1/2, 950 r.p.m.

4,721 ÷ 0.99 = 4,769 lb.

4,769 ÷ 4.94 = 965 spindles.

965 spindles ÷ 108 = 9 frames.

34 ft. 9 in. long by 3 ft. 6-1/2 in. wide.

Slubber, Warp and Filling: 0.70 hank, 15.78 lb. per 10 hours -- 12 × 6, 650 r.p.m.

6,313 + 4,769 = 11,082 lb.

11,082 ÷ 0.99 = 11,194 lb.

11,194 ÷ 15.78 = 709 spindles.

709 spindles ÷ 72 = 10 frames.

33 ft. 3 in. long by 6 ft. 10 in. wide

Drawing: 50 grains, 124 lb. per 10 hours -- 1-1/8-in. metallic, 300 r.p.m.

11,194 ÷ 0.99 = 11,307 lb.

11,307 ÷ 124 ÷ 91.2 or 6 deliveries, 4 heads, 4 frames.

40 ft. 3 in. long by 5 ft. 11 in. wide.

Drawing: 50 grains, 124 lb. per 10 hours -- 1-1/8-in. metallic, 300 r.p.m.

11,307 ÷ 0.995 = 11,364 lb.

11,364 ÷ 124 = 91.7, or 6 deliveries, 4 heads, 4 frames.

40 ft. 3 in. long by 5 ft. 11 in. wide.

Carding: 50 grains, 109 lb. per 10 hours, 10 r.p.m.

11,364 ÷ 0.995 = 11,422 lb.

11,422 ÷ 109 = 105 cards.

10 ft. 6 in. long by 5 ft. 5-1/4 in. wide.

Picking: 12 oz. 3,080 lb. per 10 hours, 9.68 r.p.m.

11,422 ÷ 0.94 = 12,151 lb.

12,151 ÷ 3,080 = 3.94 pickers.

49 ft. 0 in. long by 6 ft. 8 in. wide.

Wastes in opening and picking: 5 + 1 + 2 + 0.5 + 1.5 = 10%.

12,151 ÷ 0.90 = 13,501 lb. in the bale.

Actual loss 1,350 lb.

This loss is divided to the various operations on the above per cents.

Horizontal: Up to 15,000 lb. per 10 hours.

12,151 + 202 = 12,353 lb., 1 horizontal.

10 ft. 6 in. long by 7 ft. 6 in. wide.

Vertical: Up to 15,000 lb. per 10 hours.

12,353 + 68 = 12,421 lb., 1 vertical.

10 ft. 11 in. long by 5 ft. 7 in. wide.

Buckley: Up to 15,000 lb. per 10 hours.

12,421 + 270 = 12,691 lb., 1 Buckley

9 ft. 10-3/4 in. long by 6 ft. 5-3/4 in. wi

Bale Breakers: Up to 15,000 lb. per 10 hours

12,691 + 135 = 12,826 lb., 1 bale breaker.

35 ft. 8 in. long by 6 ft. 9-3/8 in. wide.

Raw Stock:

12,826 + 675 = 13,501 lb., in the bale.

Starting at spinning and working through weaving, using high-speed winding and warping new warp preparation and weaving equipment wo be as follows:

Winding: 13.39 lb. per 10 hours, 750 yd. per minute, 25% stops.

6138 × 0.99 = 6,077 lb.

6,077 ÷ 13.39 = 454 spindles.

454 spindles ÷ 100 = 5 frames.

44 ft. 4 in. long by 4 ft. 3 in. wide.

Warping: 412 ends, 2,550 lb. per 10 hours, 400 yd. per minute, 35% stops.

6,077 × 0.995 = 6,047 lb.

6,047 ÷ 2,550 = 2.37 or 3 warpers.

41 ft. 9 in. long by 10 ft. 5 in. wide.

Slashing: 2,472 ends, 1,763 lb. per 10 hours

6,047 × 0.99 = 5,987 lb.

5,987 ÷ 1,763 = 3.39, or 4 slashers.

43 ft. 8 in. long by 8 ft. 0 in. wide.

Weaving: 48 yd. per 10 hours, 192 picks per minute.

5,987 × 0.995 = 5,957 lb.

5,957 ÷ 0.1044 (weight warp per yard) = 57,059 yd. cloth

57,059 ÷ 48 = 1,189 looms.

7 ft. 10-3/8 in. long by 4 ft. 4 in. wide.

MACHINERY FOR 30s Warp & 36s Filling SIZE OF MILL 50,000 Spindles Print Cloth

OPERATION	SIZE	WASTE	TOTAL LB.	LB. PER UNIT	UNITS	SPEED	MACHINES	DETAILS	LENGTH	WIDTH
Raw Stock	–		13,501							
Bale Breaker	–	5.0	12,826	15,000	1	–	1	24 ft. apron	35'-8"	6'-9 3/8"
Buckley	–	1.0	12,691	15,000	1	–	1	—	9'-10 3/4"	6'-5 3/4"
Vertical	–	2.0	12,421	15,000	1	–	1	—	10'-11"	5'-7"
Horizontal	–	0.5	12,353	15,000	1	–	1	—	10'-6"	7'-6"
Picker	12 oz.	1.5	12,151	3,080	3.94	968	4	3 Beaters	49'-0"	6'-8"
Card	50 gr.	6.0	11,442	109	105.	10.0	105	—	10'-6"	5'-5 1/4"
1 Drawing	50	0.5	11,364	124	91.7	300	4-4-6	1 1/8" Met.	40'-3"	5'-11"
2 Drawing	50	0.5	11,307	124	91.2	300	4-4-6	1 1/8" Met.	40'-3"	5'-11"
Slubber	0.70 HK	1.0	11,194	15.78	709	650	10-72	12 × 6	33'-3"	6'-10"
Inter Warp	1.80	1.0	6,313	5.70	1,108	950	11-108	9 × 4 1/2	34'-9"	3'-6 1/2"
Inter Filling	2.00	1.0	4,769	4.94	965	950	9-108	9 × 4 1/2	34'-9"	3'-6 1/2"
Fine Warp	5.60	1.0	6,250	1.36	4,596	1,150	31-152	7 × 3 1/2	36'-6"	3'-4"
Fine Filling	6.70	1.0	4,721	1.06	4,434	1,150	29-152	7 × 3 1/2	36'-6"	3'-4"
Spinning Warp	30	2.0	6,125	0.22	27,840	9,525	116-240	3 1/2" gg. 1 3/4" Rg.	37'-6"	3'-3"
Spinning Filling	36	2.0	4,627	0.21	22,032	8,175	81-272	3" gg. 1 3/8" Rg.	36'-6"	3'-3"
Winding Warp	30	1.0	6,077	13.39	454	750 yd.	5-100	No. 40	44'-4"	4'-3"
Warping Warp	30	0.5	6,047	2,550	2.37	400 yd.	3	420 ends	41'-9"	10'-5"
Slashing Warp	30	1.0	5 987	1,763	3.39	–	4	2472 "	43'-8"	8'-0"
Weaving Filling	30-36	0.5 1.0	5,957 4,581	48 yd.	1,189	192 picks	1,189	2472 "	7'-10 3/8"	4'-4"
			10,538 total (no size)							

Coarse Sheeting Machinery.

As a mill making coarse sheetings is likely to have quite a variable demand for the different counts spun, it is not possible to calculate machinery which will always be in balance. The solution given here illustrates what may be done when a given number of spindles is specified and the yarns are desired in some particular proportion. The problem is worked as a general solution which may be applied to any number of counts desired in any particular proportion.

Assuming 10s, 14s, 18s, and 22s are taken as warp counts, and 12s, 16s, 20s, and 24s are taken as filling counts, calculate the necessary spinning and roving spindles for a 20,000-spindle mill on the assumption that equal weights of each count are to be spun.

As each count is produced at a different rate, the spindles cannot be divided equally. On the other hand, there is no way of telling the total poundage until the number of spindles making the count is determined. Consequently, it is necessary to start with an assumption. In this case, the assumption is that 100 lb. of each count will be spun to find the percentage of spindles to put on each count. On this basis, it is possible to determine the spindles per 100 lb. of each count and from these figures to find the percentage of spindles for each count.

Figures as determined from tables and assumptions are given in Table I. The first column shows the counts, the second the spindle speed, the third the pounds per spindle for 10 hours, the fourth the spindles necessary to product 100 pounds in 10 hours, the fifth the percentage of spindles necessary for each count, and the sixth the number of spindles of the 20,000 to use for each count. (Three decimal places are quite unnecessary, but have been used here to make these theoretical figures total exactly 100%.)

The pounds of each yarn produced may be found by multiplying the pounds per spindle (column 3) by the spindles used (column 6). For example, 18s warp would be produced by 2,782 spindles spinning 0.43 pounds per spindle, a total of 1,196 pounds. As there are eight lots, the total pounds spun would be 8 x 1,196 = 9,568 pounds 10 hours.

TABLE I -- Spinning Spindles for Each Count

Counts	Spindle Speed r.p.m.	Lb. per Spindle 10 Hr.	Spindles per 100 Lb.	Percent of Spindles	Spindl out 20,00
Warp					
10	7,500	0.89	112.5	6.723	1,34
14	8,250	0.59	169.5	10.139	2,02
18	8,700	0.43	232.6	13.912	2,78
22	9,050	0.33	303.0	18.123	3,62
Filling					
12	6,550	0.73	137.0	8.194	1,63
16	7,150	0.54	185.2	11.077	2,21
20	7,600	0.42	238.1	14.241	2,84
24	8,100	0.34	294.1	17.591	3,51

In determining the roving spindles to use (Table II), it is first necessary to note that the 24s are spun from 3.30-hank, 22s and 20s fi 3.00-hank, 18s and 16s from 2.50-hank, and 14s from 2.25-hank fine roving. The 12s and 10s a from 1.60-hank intermediate roving and do not appear in calculating fine spindles.

Allowing 2% spinning waste in each lot of 1,196 pounds of yarn requires 1,220 pounds of fine roving. It is possible to divide this fig ure by the pounds per spindle to find the fine spindles needed. Where two yarns are spun from the same roving, merely double the quantity of roving needed.

Three counts of yarn are spun from one intermediate roving in two cases and two counts in the other case. Note that for the last two counts it is necessary to use 1,220 pounds, while with the others it is necessary to allow a fine-roving waste. For the fine frame, 1% waste is allowed, making each lot 1,220 ÷ 0.99 = 1,232 pounds. As there are three lots of yarn from each of these batches of roving, the final figure is 3 x 1,232 = 3,696 pounds.

On the slubber, the counts 14s through 24s are all made from 0.50-hank roving and the 10s and 12s from 0.60-hank roving. Waste on the intermediate is figured at 1%.

TABLE II -- Fine Spindles. 8 x 4.

Counts Spun	Hank Roving	Lb. Needed	Lb. per Spindle	Spindles
24s	3.30	1,220	**2.70**	**452**
22s & 20s	3.00	2,440	**3.05**	**800**
18s & 16s	2.50	2,440	3.89	627
14s	2.25	1,220	4.48	272

TABLE III -- Intermediate Spindles. 10 x 5.

Counts Spun	Hank Roving	Lb. Needed	Lb. per Spindle	Spindles
24s, 22s & 20s	1.20	3,696	9.11	406
18s, 16s & 14s	1.00	3,696	11.38	325
12s & 10s	1.60	2,440	6.21	392

TABLE IV -- Slubber Spindles. 12 x 6.

Counts Spun	Hank Roving	Lb. Needed	Lb. per Spindle	Spindles
24s through 14s	0.50	7,466	24.00	311
12s & 10s	0.60	2,465	19.25	128

Mill For Sale.

Advertisement

FOR SALE

35,000 spindle cotton yarn unit, from Pickers to Ring Spinning Frames, and we will sub-divide into three or four separate units if desirable.

The machinery consists as follows:

2–Opener Breakers.
4–Finisher Lappers.
66–Revolving Top Flat Cards.
126–Deliveries Drawing.
6–Slubbers—10x5½—100 spindles each.
10–Intermediates—9x4½—124 spindles each.
16–Roving Frames—8x3½—244 spindles each.

35,000 spindles Ring Spinning Frames, Whitin, Fales & Jenckes and Mason make.

All this machinery can be seen in operation, and is suitable for the manufacture of from 20's to 40's cotton yarn.

When looking for equipment to produce a given product, a mill may have the problem of determining whether some available plant is suited to its work. Of course, it is always possible to lay out the expected drafts and sizes, and to calculate the desired equipment and compare it with any offered. On the other hand, it is about as simple to take a given lot of machinery and determine what can be done with it. Using this second approach, the following problem has been worked out for a condition where a mill wishes additional equipment to spin 30s warp yarn.

The equipment listed in the advertisement was offered for sale, and the question was whether this equipment was suitable to produce 30s and be balanced in production.

In this illustration the quantity of yarn which this spinning may produce is calculated. Then, knowing the number of fine spindles, it is possible to calculate the pounds each fine spindle must produce each day. Taking this figure to the catalog, what hank roving must be run to produce this number of pounds can be determined. Repeating these calculations for each operation, it is possible to get a series of sizes for the operations. Then this may be considered as an organization. If it does not seem practical, possible variations may be considered. Following this procedure gives the following calculations:

Spinning. 35,000 Spindles.

35,000 spindles, 30s at 0.22 lb. = 7,700 lb. yarn.

Roving. 16 Frames, 244 Spindles.

3% spinning waste. 7,700 ÷ 0.97 = 7,940 lb. fine roving.

16 x 244 = 3,904 fine spindles.

7,940 ÷ 3,904 = 2.03 lb. per spindle.

8 x 3-1/2 frame, 4.15 hank fine roving.

Intermediate Roving. 10 Frames, 124 Spindles

1% fine waste. 7,940 ÷ 0.99 = 8,020 lb. intermediate roving.

10 x 124 = 1,240 intermediate spindles.

8,020 ÷ 1,240 = 6.47 lb. per spindle.

9 x 4-1/2 frame. 1.63-hank intermediate roving.

Slubber Roving. 6 Frames, 100 Spindles.

1% intermediate waste. 8,020 ÷ 0.99=8,100 lb. slubber roving.

6 x 100 = 600 slubber spindles.

8,100 ÷ 600 = 13.5 lb. per spindle.

10 x 5-1/2 frame. 0.80-hank slubber roving.

Drawing. 126 Deliveries.

1% slubber waste. 8,100 ÷ 0.99 = 8,180 lb. drawn sliver.

8,180 ÷ 126 = 65 lb. per delivery.

(As this is too low a production for drawing, there must be enough machinery for two proce es.

8,180 ÷ 63 = 130 lb. per delivery.

(Assume these rolls are 1-1/8 in. in diameter, suited to short cotton, also that they are

metallic rolls.)

sing 290 r.p.m. at the front roll, 55-grain liver (use this for both operations tentatively).

arding. 66 Cards.

% drawing waste. 8,180 ÷ 0.99 = 8,260 lb. card sliver.

,260 ÷ 66 = 125 lb. per card.

sing 10.5 r.p.m. at the doffer, 55-grain sliver.

inisher Pickers. 4 Pickers.

% carding waste, 8,260 ÷ 0.92 = 8,980 lb. finisher lap.

,980 ÷ 4 = 2,245 lb. per picker.

sing 6.54 r.p.m. calender rolls, 13-oz. lap.

reaker Pickers. 2 Breakers.

% finisher waste. 8,980 ÷ 0.98 = 9,160 lb. breaker lap.

,160 ÷ 2 = 4,580 lb. per breaker.

sing 11.0 r.p.m. calender rolls, 15.5-oz. lap.

The third column of Table I shows the rafts which must be used at each operation or the various sizes shown.

A brief study of the summary will show hat 30s should be spun from single roving this plant. If an attempt was made to produce finer fine rovings, the roving spindles ould not produce enough roving to supply the mand of the spinning room. If long-drafting s applied to these spinning frames, double ving would be very practical with a draft of out 16. In the roving section, drafts of 09 and 4.07 for the fine and intermediate ames, respectively, are low; while a draft 5.28 for the slubber is high.

In reorganizing the roving drafts, it is ite obvious that the same total draft must used, but that it should be rearranged. e product of the three roving drafts in the

TABLE I -- Summary of Tentative Organization

Operation	Size	Draft	Doubling
Spinning.....	30.0	7.68	1
Fine.....	4.15	5.09	2
Intermediate.....	1.63	4.07	2
Slubber.....	0.80	5.28	1
Drawing.....	55.	6.00	6
Drawing.....	55.	6.00	6
Card.....	55.	95.2	1
Finisher.....	13.	4.67	4
Breaker.....	15.5	-	-

tentative layout is 5.09 x 4.07 x 5.28 = 109.4. The product of the new drafts should equal this figure. If 6 x 5 x 4 is tried, the product, 120, is too great. If each of these is reduced slightly, the product of 5.9 x 4.9 x 3.9 is 112.7, which is still too high. If 5.8 x 4.8 x 3.8 is tried, the result is 105.8, and is too low. As 109.4 is just about half way between these totals, the necessary drafts would be just half way between these two trials. Table II shows the new organization.

TABLE II — Revised Summary of Organization.

Operation	Size	Draft	Lb. per Spindle	Spindles Needed
Spinning.....	30.00	7.68	0.22	35,000
Fine.....	4.15	5.85	2.03	3,904
Intermediate...	1.42	4.85	7.70	1,042
Slubber.....	0.58	3.85	19.85	408

A comparison of the intermediate and slubber operations in the tentative and the revised summaries shows that it is possible to improve the drafts in roving and to eliminate about 200 spindles in each operation; that is, one pair of slubbers and nearly one pair of intermediates.

In the drawing, 63 deliveries per operation is not likely to be practical. These are probably 6-delivery heads and it would be necessary to use 60 and 66 deliveries for the two operations.

Using 60 deliveries for the first drawing, and running them at about 300 r.p.m., would take care of the necessary production. The second drawing, with 66 deliveries, could be run 275 r.p.m. to take care of the stock.

The four finisher pickers are more than ample for the needs of the rest of the equipment. Three of these running at 3,000 lb. would make a very practical - even conservative - arrangement. Two breaker pickers are not sufficient, as they are running a heavy lap at a high calender roll speed.

Any modern installation would use some opening equipment, which this mill apparently did not have. When adding opening machinery, it would be likely that the pickers would be changed to make three single-process pickers. The conclusion is that, physical condition being satisfactory, this equipment will serve to spin 30s warp yarn.

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